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Volume XXVI JUNE, 1918 Number 6

Surgery, Gynecology and Obstetrics

WITH

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SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXVI JUNE, 1918 NUMBER 6

MILITARY ASPECTS OF THE SURGERY OF THE SPINE AND SPINAL CORD[1]

BY CHARLES H. FRAZIER, M.D., F.A.C.S., PHILADELPHIA

AS the United States is now mobilizing its medical forces for service in the War Zone it seems appropriate at this representative gathering of surgeons that a major portion of the time should be given to the consideration of military surgery. Never before in the organization of the country's forces in preparation for war has there been such an effort to take advantage of the training and qualifications represented in the specialties of medicine so that the round peg will find the round hole and the square peg the square hole.

Neurological surgery has been recognized as demanding special consideration and to this end a school in neurological surgery has been inaugurated in Philadelphia by the Surgeon General to prepare a selected number to take care of gunshot injuries of the head and spine. Already one class has completed an intensive course, another course is now under way and arrangements are being made for the inauguration of courses in other cities.

Rather pessimistic reports come to us as to the results obtained in the treatment of head and spine injuries. These may be justified in part by the inability to combat infection of the brain and cord, as it has been so effectively done in the extremities and in surface wounds and by the lack of reparative power peculiar to the central nervous system. But I am told by those who have been at the front, that the high mortality rate must be attributed in part to crude and ineffective methods, applied by those who have had little experience and training in dealing with lesions of the central nervous system. There would seem, therefore, ample justification for the plan for providing the opportunity for military surgeons to receive such instructions as will enable them to deal with greater intelligence and confidence with gunshot injuries of the cord, spine, and peripheral nerves.

In the literature of the present war, the surgery of the central nervous system has been the topic of many valuable contributions but, relatively speaking, the large majority has been devoted to the brain rather than the spine. But the subject of spinal cord injuries has by no means been neglected. My remarks this evening will be devoted to the consideration of those phases of gunshot injuries of the spinal cord as have practical import and value.

Wounds of the spine and spinal cord occur at every level, although they are most frequent in the thoracic region, chiefly because it is longer and, therefore, more exposed. Out of 642 cases of gunshot injuries of vertebræ recorded in the *Medical and Surgical History of the War of the Rebellion*, 91 were in the cervical region, 137 in the thoracic, 149 in the lumbar, 2 in the cervical and thoracic, 3 in the thoracic and lumbar,

[1] Presented before the Clinical Congress of Surgeons of North America, Chicago, October 24, 1917.

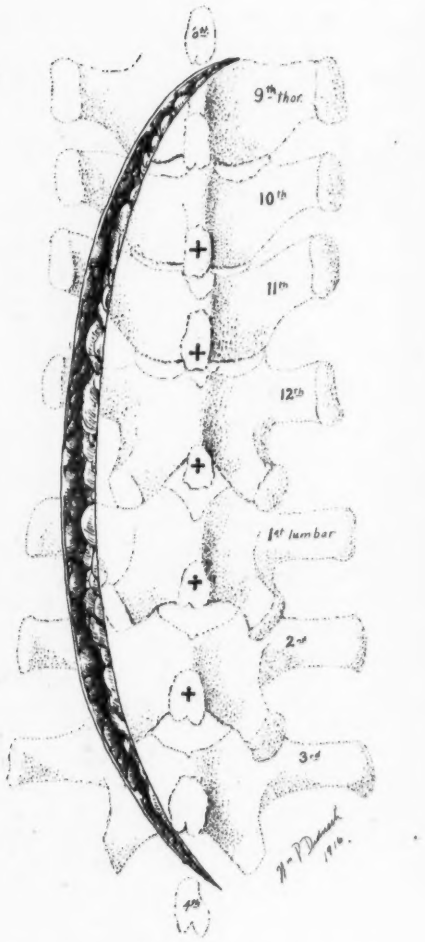


Fig. 1. This illustration shows the length and relation of the semilunar incision in the skin to the spinous processes for a laminectomy to include the tenth, eleventh, and twelfth thoracic and first and second lumbar vertebræ.

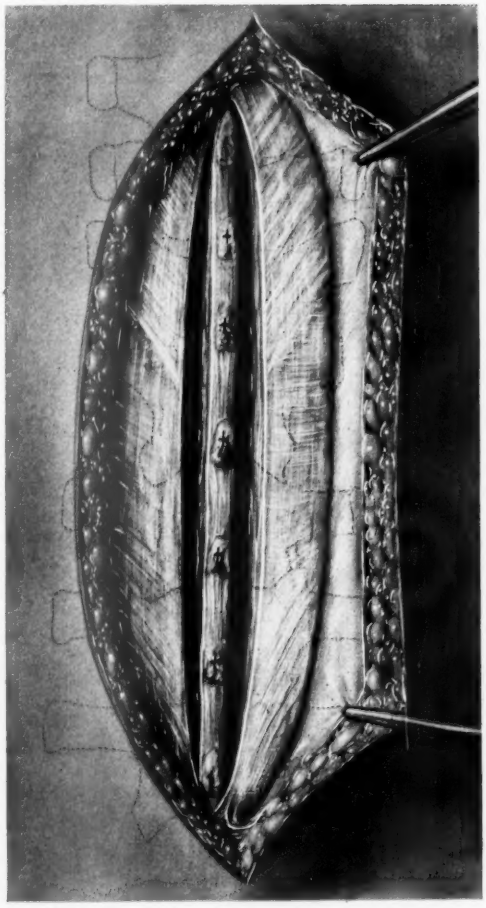


Fig. 2. The cutaneous flap is reflected, showing the oval incision in the intervertebral fascia beginning one spinous process above and one spinous process below the contemplated opening in the spinal canal.

and in 260 cases the location was not stated. In a group of more than 300 cases seen by Gordon Holmes in the present war, the injury most often affected the thoracic region and the cervical enlargement, although he has seen every segment involved from the second cervical to the conus. In 65 cases the lesions were situated between the sixth and ninth thoracic segments, and in the fourth, fifth, or sixth cervical segment in 51 cases. According to Guillian and Barre the largest number of spinal injuries in the present war is due to shell fire. In their experiences 61 per cent were due to shells, 23 per cent to bullets, and 8 per cent to shrapnel.

The bone lesions resulting from gunshot wounds of the spine are varied, depending partly upon the portion of the vertebra involved and partly upon the shape and velocity of the projectile and upon whether it has ricocheted or followed a straight course.

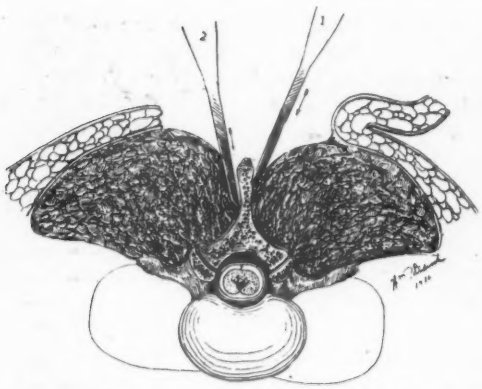


Fig. 3. Separation of the muscles from the tip of the spinous process.

Fractures of the compact and thin parts, particularly the arches, spinous and transverse processes, are common. The same projectile, particularly if it be a ricocheting bullet, may involve several arches and their processes, and if its power of penetration be sufficiently strong at the point of impact, it may cause indirect fracturing of the arches and processes immediately above or below those directly involved. Associated with these fractures, there is considerable splintering and fissuring of bone. Indeed, the force of impact and velocity of the modern bullet are so great that dislodged spicules of bone and metallic particles of the projectile itself, and bits of clothing, may be carried forward into the spinal canal.

The bullet may strike the spinal column anteroposteriorly instead of in the more usual postero-anterior direction. In this case there is usually, in addition to the spinal injury, a wound of the pelvic, abdominal, or thoracic viscera. The bone lesion is not so severe, however, as gunshot injuries seldom cause a comminuted fracture of the vertebral bodies. The bodies of the vertebræ are less compact and therefore are perforated, notched or fractured, by the projectile in a more or less clean-cut fashion. If the course of the projectile be transverse or oblique, the transverse and articular processes are chiefly involved.

While the bullet may become lodged in the vertebral bodies, in the laminæ, or other processes, or in the vertebral canal, it more often happens, owing to the greater momentum of the modern projectile, that the bullet either passes through the entire spinal column or, in case the bone at the point of contact be more resistant, it may rebound without penetrating the bone and become embedded in the soft parts at some distance from the spine. Occasionally, instead of remaining in its original location, the bullet, sinks to a lower level of the canal.

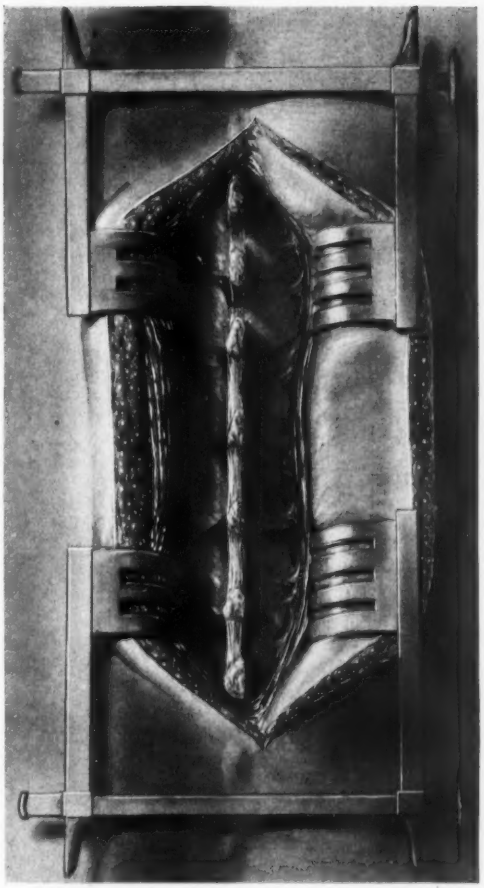


Fig. 4. Two pairs of self-retaining retractors introduced, one at the upper and one at the lower angle of the wound.

The cord may suffer in a variety of ways, both directly and indirectly. It may be

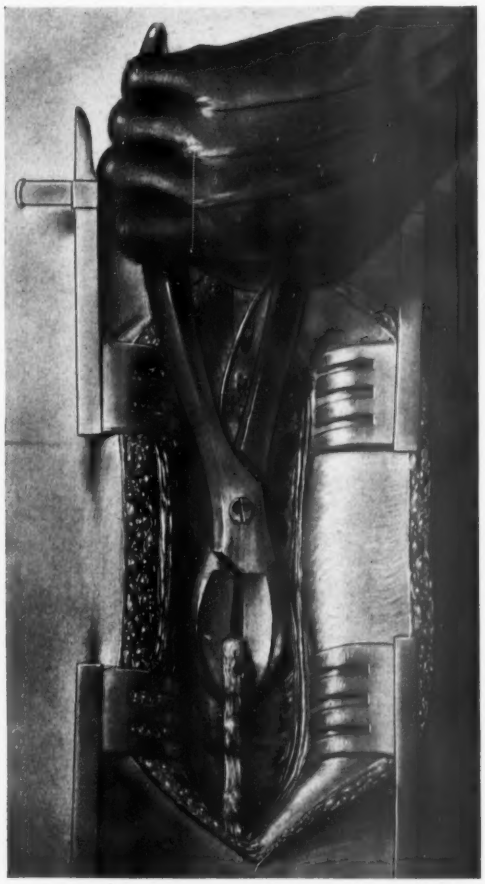


Fig. 5. Removal of the spinous processes.

severely lacerated or even completely severed by direct contact with the bullet or indriven piece of bone; it may be compressed by displaced fragments of bone, by the bullet protruding into the canal, by a subdural hæmorrhage, by adhesions or serous exudates; it may be contused by the bullet and accompanying splinters of bone; finally the cord may undergo grave structural changes from the effects of concussion or commotion caused by a bullet striking some portion of the vertebral column and bounding back to become lodged in the soft parts, or the sudden atmospheric changes produced by exploding shells may result in changes.

The structural changes in the cord, the result of laceration, contusion or compression, have been described with great faithfulness; not only those at the site of impact but those remotely situated. In many respects the pathological changes do not differ materially from those observed in civil injuries, consequent upon fractures; they are chiefly œdema, hæmorrhage, primary destruction and secondary disintegration.

Considerable interest and speculation have been aroused as to the mechanism of a spinal concussion. The term concussion, as applied to the brain, implies a condition in which, while there may be all grades of functional disorders, even to complete functional arrest and death, the absence of gross or microscopical changes in the brain is conspicuous. In spinal concussion, however obscure and speculative may be the manner of its production, structural changes even to the point of complete disintegration are a more or less constant feature.

In most cases of spinal concussion the bullet strikes the vertebral column and rebounds, to become embedded in soft tissue or an organ often at some distance from the spine. The momentum of the modern bullet is so great at the time of impact that the vibrating force is transmitted to the cord with damaging effect. Many explanations have been offered as to the cause of these changes. While in some momentary displacement may be a factor, the pathological lesions of concussion are not those common to fracture or dislocation. The effects of concussion have been attributed to the waves of pressure set up in the spinal canal and the disturbance of the lymphatic circulation caused by the concussion. According to Fickler, the cord is made to oscillate within the canal at the time of impact, and since its movements are not synchronous with those of the column, it may be directly injured by contact with the walls of the canal. The displacement of the cord would easily account for histological changes in the roots.

Whatever the mechanism may be, the fact remains that spinal concussion, produces both definite and serious lesions of the cord characterized by their diffuse and irregular

Fig. 6. Exposure of the vertebral column after the spinous processes have been removed.

manifestations. These processes include œdema, hæmatomyelia, hæmatorachis, disseminated foci of necrosis, softening and cavity formation, and parenchymatous changes, often over four or five segments in either direction.

There is still another group of cases in which the clinical picture and the autopsy findings show grave involvement of the spinal cord, but in which there has been neither a direct nor an indirect injury to the spinal column. These are attributed to the sudden changes in atmospheric pressure caused by the explosion of the modern shells and grenades. The victim immediately falls to the ground with all the signs of a partial or complete transverse lesion, and autopsy may reveal the various macroscopical and microscopical changes above mentioned.

Accurate localization is essential to the success of operations upon the brain and cord, and I think this statement is, if anything, more true of the cord than of the brain. It is important, therefore, that we should inform ourselves as to all the physical signs that have to do with the exact localization of the lesion, the exact determination of the level of the injury. Here, again we are reminded of the necessity for specialized service. Neurological examinations are tedious and time-consuming and for their accurate performance require training and experience. Furthermore, not only one but repeated

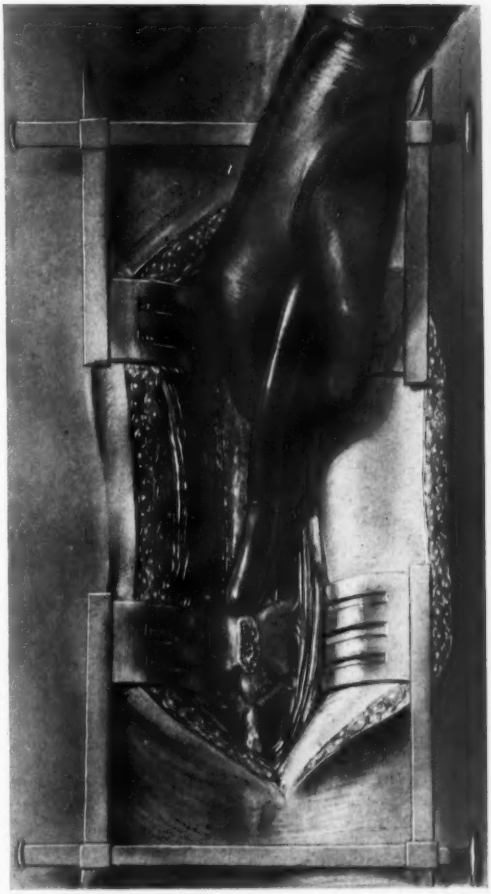


Fig. 7. Removal of the laminæ.

examinations are required in individual cases, before resort to operation is determined. In the general hospital, with the rapid influx of patients and the necessity of hasty evacuation, how little opportunity there is for the painstaking service and study which those suffering from injuries to spine and cord require. Possibly because of the indifferent treatment of these cases in the general hospital, England has attempted segregation, and it is hoped that this country will find it possible to erect in the War Zone, hospitals to be devoted exclusively to injuries of the central nervous system. At the time of our

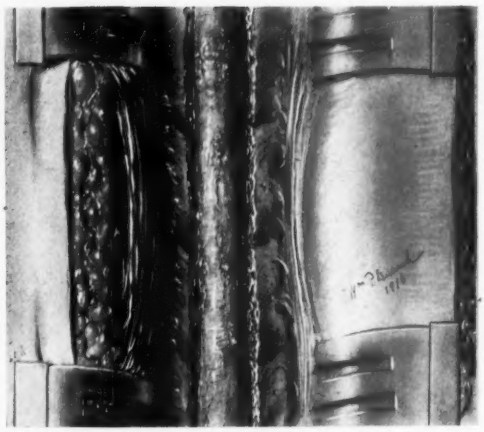


Fig. 8. Exposure of the spinal cord after the removal of the laminæ.

Civil War the Surgeon General ordered the establishment of special hospitals for the treatment of diseases and injuries of the nervous system and even then it was considered essential to the care of the patient that the surgeon and the neurologist work hand in hand.

To Gordon Holmes, the distinguished neurologist, more than to any individual observer, are we indebted for the accurate portrayal of the clinical picture of cord lesions, more particularly in regard to localization, and from his contribution I have drawn freely in the presentation of this phase of the subject.

The cord symptoms vary according to the nature, the seat, and the extension of the lesion. We may recognize four groups:

Group 1 comprises the complete transverse lesion with total and absolute flaccid paralysis below the level of injury, with abolition of all reflexes and all forms of sensation.

Group 2 includes the partial lesions, the spinal hemiplegia or the more or less typical Brown-Séquard syndrome:

In Group 3 may be placed the lesions of compression characterized by spastic paraplegia, exaggerated reflexes, and positive Babinski.

Group 4 comprises the lesions of the cauda equina.

In the past we have been in the habit of laying more emphasis on the upper level of sensory disturbances as indicative of the level of the lesion than upon the evidences of motor impairment. As a matter of fact in many instances the sensory disturbances are more difficult of interpretation and less useful, therefore, than the motor. While we have recognized the localizing value of paralysis of isolated muscles or groups of muscles in the upper or lower extremities, the diagnostic value of paralysis of muscles in the trunk has been overlooked. Holmes believes this to be of great value in making a topographical diagnosis of lesions of the six lower thoracic segments. For example, if the eleventh segment be involved, we find paralysis of the lower portion of the external and internal oblique with bulging of the iliac regions, while the whole rectus abdominalis contracts when the patient raises his head or coughs. If the ninth segment be affected, the lower part of the rectus abdominalis is paralyzed, while the upper part contracts vigorously. The condition of the intercostals is also very valuable in the localization of lesions, particularly of the upper thoracic segments. By placing the finger over an intercostal space, the muscle will be felt to contract strongly on each inspiration if it be not paralyzed. This is a valuable guide, since each intercostal muscle receives its nerve supply from the corresponding thoracic root.

While accurate charting and interpretation of the sensory disturbances is an aid in making a topographical diagnosis, these are by no means infallible, particularly in cases of incomplete or unilateral lesions, chiefly because of the decussation of the sensory fibers and their oblique course within the cord. It should be borne in mind, moreover, that the decussation occurs quickly in the midthoracic region, gradually becoming slower as we go upward. Certain phenomena, such as the lowering of the upper level of anæsthesia and the escape of early reappearance of sensation in the caudal region, have given a new insight into the arrangement of the sensory fibers of the second order, as they ascend through the ventrolateral column.

According to Holmes they indicate "a lamellar arrangement in which the fibers that carry any specific form of sensation from successive dorsal roots lie in series; and as there is a general law that the longer descending fibers lie nearer the periphery of the cord, those that convey impressions from the lower spinal roots are probably placed lateral to those that have later reached the contralateral side. The escape of the sacral root areas would therefore indicate a lesion that involves only the more mesial fibers of the sensory path, while an anæsthesia disproportionately low in relation to the level of the spinal injury would suggest a local destruction of its more lateral fibers. When it becomes possible to correlate the exact histological changes in these cases with the results of careful clinical examinations, definite conclusions on the exact course of the fibers that carry various sensations from different regions of the body will be possible."

Holmes has found the disturbance of deep sensations, particularly the sense of vibration, a help in those cases of lesions limited to the dorsal columns in which the sense of touch and pain is unaffected. In these cases the vibrations of a heavy tuning fork are not recognized below the level corresponding to the injured segment. Since the thorax may act as a sounding box, the fork must be applied in this region only to folds of the skin which have been raised. On the other hand, in cases of unilateral lesions in which pain and temperature sensation are completely lost, those forms of sensation conducted by the dorsal columns are often intact. In some cases homolateral astereognosis has been found to be present when tactile sensibility was otherwise unaffected. In incomplete transverse lesions, anæsthesia to pain and temperature is almost invariably present, while tactile sensation may be preserved. Above the twelfth thoracic segment, unilateral lesions take the form of a more or less typical Brown-Séquard syndrome. The studies in the present war seem to corroborate the views of Head and Thompson that thermal stimuli of all degrees are conducted by the same intraspinal paths, but that heat and cold are conducted by separate fibers.

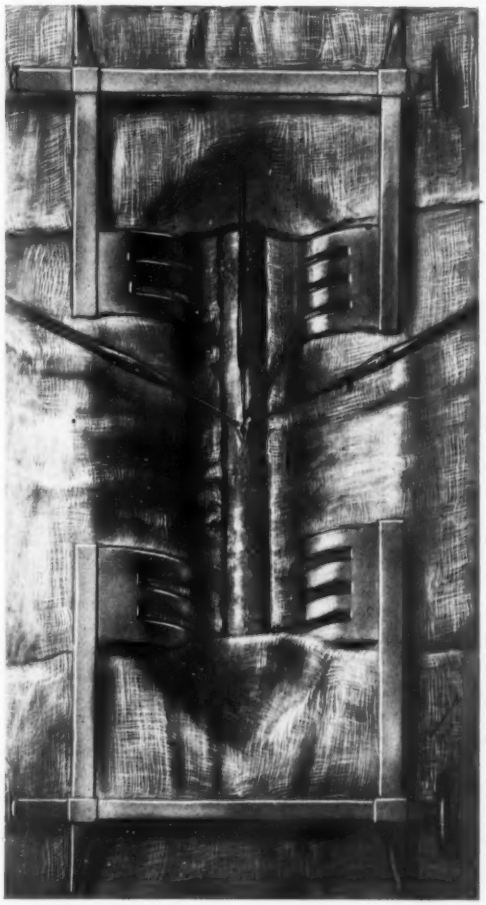


Fig. 9. This illustration shows the general appearance of the operative field before the dura is opened. The musculocutaneous structures down to the level of the dura are entirely covered with gauze pads. Traction sutures have been introduced in, but not through, the dura as the incision in the dura is begun.

As indicative of lesions between the second cervical and second thoracic segments are the symptoms, which result from disturbances of the cervical sympathetic: the myosis or inequality of the pupils, the narrowing of the palpebral fissure, the enopthalmos, the diminution of tear secretion, flushing of the face (especially after shaving), and diminution of sweat or relative dryness of the skin on the affected side.

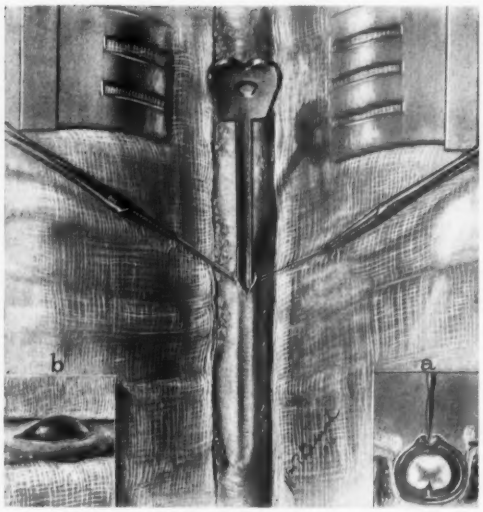


Fig. 10. The introduction of the groove director through the initial opening in the dura. *a*, The knife in place in the groove of the director as the dural incision is made: *b*, the thin filmy arachnoid membrane ballooning through the dural incision.

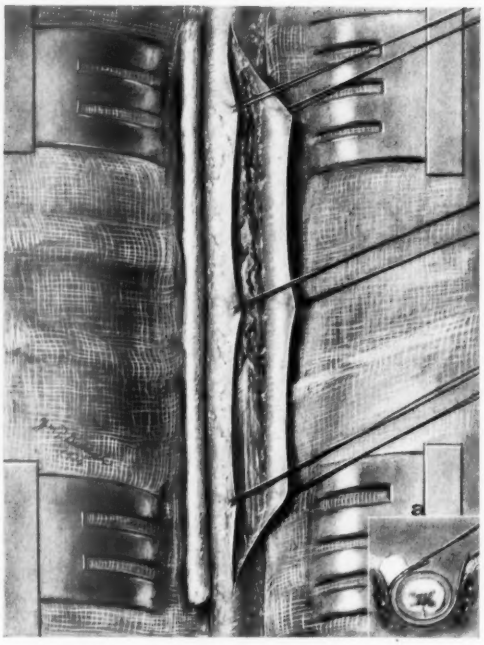


Fig. 11. After the three pairs of traction sutures have been introduced, a roll of cotton is laid in the trough on either side of the dural flap to absorb the blood, which may gravitate to the bottom of the wound, and to prevent its entrance within the dural sac. *a*, Representing in cross section the relation of the cotton roll to the dural sac.

An interesting syndrome in lesions of the lower part of the cervical enlargement is represented by slow pulse, subnormal temperature, low blood pressure, and scanty secretion of urine. The temperature in some cases is lower than can be registered by a clinical thermometer, the pulse rate from 30 to 50, rising or falling with the rise and fall of temperature, and the urinary secretion sometimes entirely suppressed.

As an occasional symptom in lesions of the lower cervical and three upper thoracic segments, Collier mentions persistent shivering of the face, neck and shoulders without any sense of coldness on the part of the patient, although a rise in temperature is a much more common accompaniment of lesions of the cervical cord.

In one case observed by Leyva, the involvement of certain medullary centers was expressed in the paralysis of the recurrent laryngeal nerve, in a unilateral atrophy of the tongue and difficulty in swallowing. Bilateral and unilateral paralysis of the diaphragm point to a lesion of the cervical cord as far down as the fifth cervical segment.

As significant of lesions of the thoracic segments of the cord, I may remind you of abdominal distention in some cases associated with muscular rigidity and more or less persistent vomiting. The association with the latter of girdle pains and hyperæsthesia of the skin between the ensiform cartilage and the umbilicus would indicate a lesion of the sixth, seventh, eighth, and possibly ninth thoracic segments, and reminds one of the gastric crises of tabes and the relief afforded by section of the posterior roots of the corresponding cord segments.

Recently, I have had under observation a patient with an acute inflammatory condition of the fifth and sixth thoracic segments, in whom polyuria has been a striking symptom. The boy, age 16, voided for several weeks from 150 to 200 ounces of urine per day, due in all probability to arrest of function of the vasoconstrictor fibers of the kidney.

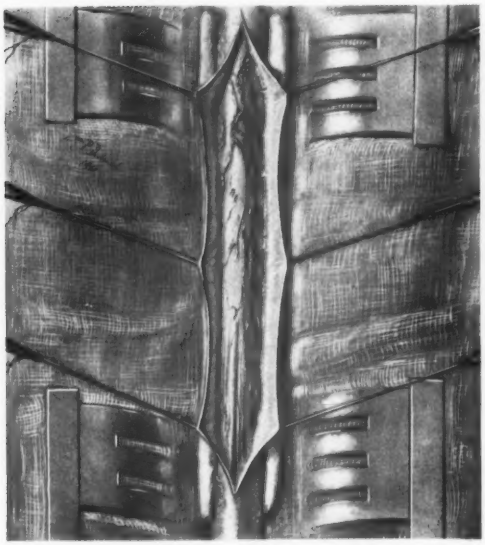


Fig. 12. The appearance of the operative field after the dural flaps have been reflected with traction sutures.

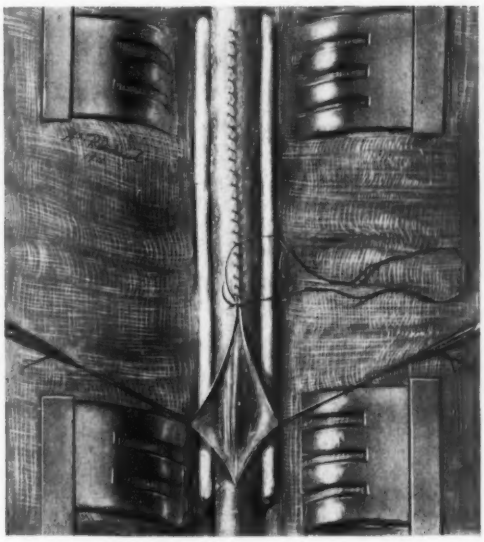


Fig. 13. Closure of the dural incision with continuous silk sutures.

The rôle of the X-ray in the localization of lesions and in revealing the extent and nature of the injury has been disappointing. A careful neurological examination has proved more reliable in determining the level of the lesion, as the gravity of the skeletal lesion bears no relation to the degree of cord injury.

I recently examined two X-ray plates of gunshot injuries of the spine from the war zone. In the first plate two vertebral bodies appeared shattered but there had been no injury to the cord; while in the other the plate showed no evidence of fracture or foreign body but the case presented all the symptoms of a complete transverse lesion. Fracture of the spinous processes or depressed fractures of the laminæ are not easily brought out by the X-ray and even with stereoscopic pictures it is not always easy to determine whether a bullet lies within or without the spinal canal. However, X-ray pictures should be taken routinely in the hope of eliciting the site of a bullet or the presence of a dislodged fragment and to determine if possible whether the bullet be within the spinal canal.

The treatment of gunshot wounds of the spine is a complex problem. The momentous question in most instances is whether an exploratory laminectomy be indicated and, if indicated, how soon after the injury should it be performed. A judicial decision in these matters must take into consideration many factors: the facility for performing the operation, the presence of a complete transverse or an incomplete transverse lesion, the presence or absence of bullets or fragments within the vertebral canal, an open or closed wound, a direct injury to the cord, as from compression, or an indirect injury as from concussion.

Let us consider first the treatment of indirect injuries to the cord, those due to an explosion in the vicinity or to the impact of a bullet against the vertebral column, without direct impact on the cord, or to the passage of a bullet adjacent to, but not involving, the vertebral column. In this category, it must be borne in mind that the interference with cord function may at first be quite as pronounced as when the cord is actually severed by a bullet. At the outset the picture may be one of a complete transverse lesion, even though it be the re-

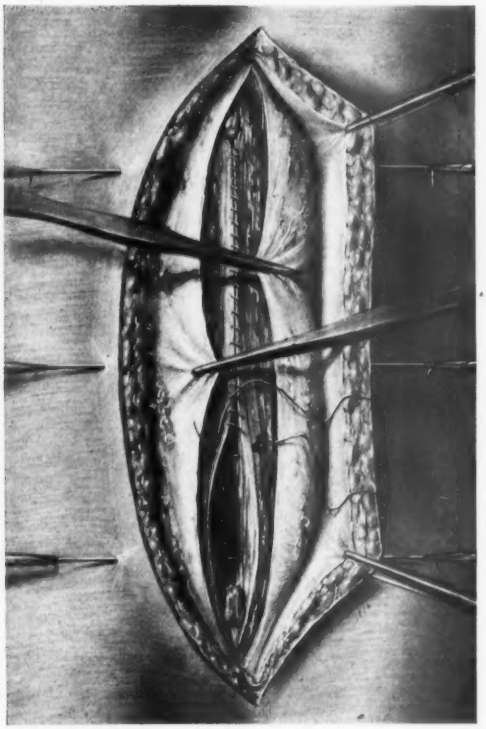


Fig. 14. Continuous catgut suture which penetrates only the muscle sheath.

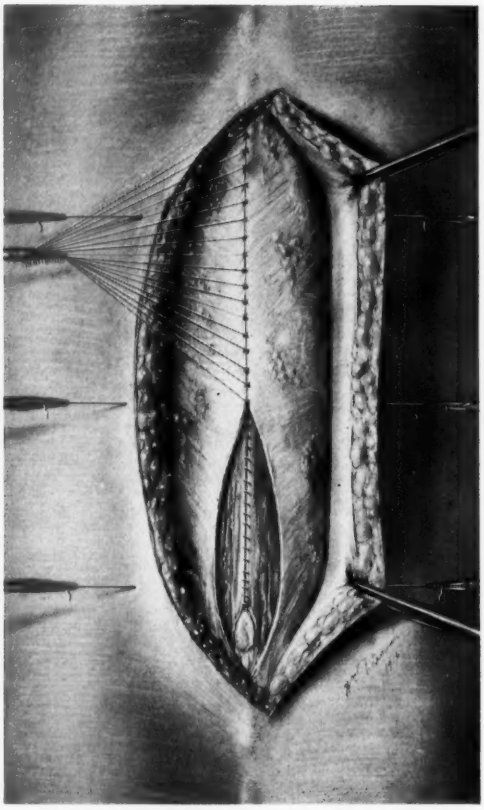


Fig. 15. Interrupted catgut sutures in the intervertebral fascia.

sult of concussion alone. Under these circumstances early operation is clearly contraindicated. However, should the symptoms persist without amelioration, an exploratory laminectomy under suitable circumstances may be considered within the limits of propriety, on the grounds that the persistence of symptoms may be the result of hæmorrhage or an undetected injury of the vertebral column. Be it remembered here, as in other parts of this discussion, that the clinical evidence of a total or complete transverse lesion does not signify an irreparable injury to the cord. In fact, so often has the interpretation of the signs of a total lesion been found misleading that surgeons are rather prone to seize this as a valid argument in favor of frequent recourse to exploratory laminectomy. Along these lines Armour puts the question: "Are there any symptoms by which we can in a reasonable time determine beyond a doubt that we are dealing with a case either of complete transverse section or of pure concussion? If there are not, then should not we be urged to give our patient the benefit of an operation which experience shows neither materially endangers his life nor adds to his discomfort, but actually lessens his pain? It will at least afford us the opportunity to determine the exact nature and extent of the lesion and to place the cord under the most favorable condition for recovery of function, if recovery be possible."

When dealing with *direct* injuries to the cord by bullet, shrapnel, or bone splinters the propriety of a laminectomy admits of little

discussion. This general dictum, with certain qualifications, has been subscribed to quite generally by neurologists and surgeons alike who have had opportunity for abundant observation during the European War.

While it may be true of the individual case, as it is no doubt of a large number, that the damage to the cord is accomplished at the time of the accident, and that the persistence of symptoms is the result not of continued compression but of the intramedullary changes in the cord due to the original impact, an exploratory laminectomy should be performed, whether the picture be one of a complete or incomplete lesion.

One may assume that if the injury is due to shrapnel, the cord is more apt to be hopelessly damaged than by a bullet. But after all the nature of the cord lesion is largely a matter of conjecture, and there is the temptation to take the position, endorsed as it is by Oppenheim, that operation is indicated even in cases of total transverse lesion, for there is nothing to lose, and perhaps, something to be gained. In twenty operations for gunshot injuries of the spine Guleke found the cord completely crushed in ten, and while only five of the twenty cases recovered, three of these would have died had not fragments of bone or bullets been removed.

As to the time of operation, there are those who urge immediate operation, and those who advise waiting from three to five weeks, or until the likelihood of recovery seems remote. Whatever may be the view of the individual surgeon, it is at least true that no operation should be undertaken until the patient has recovered from shock, and not until the patient reaches a base hospital from which he will not have to be transferred until the fractured spine has been well repaired. Authorities agree that secondary changes are more likely to develop as a result of early transportation and therefore absolute rest is advisable in the convalescent period if the condition offers any prospect of useful recovery.

Included among the later indications for operation are the symptoms attributable to the pressure of an organized exudate, of callus, of a traumatic pachymeningitis, or of a

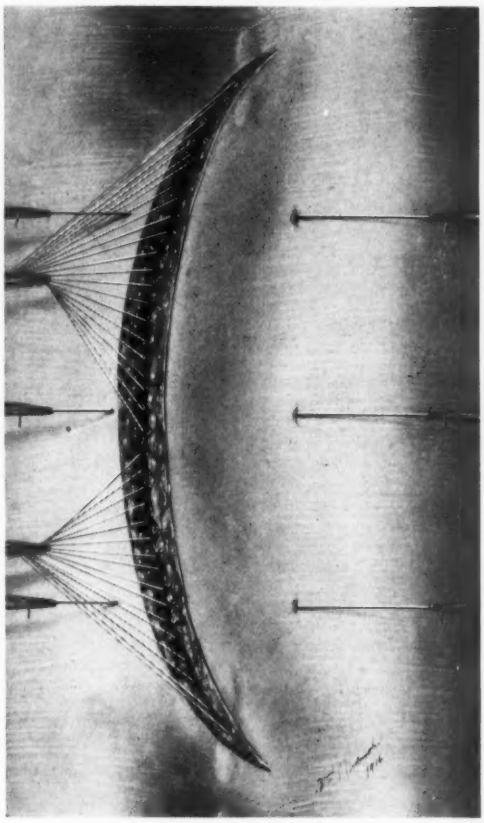


Fig. 16. Closure of the superficial fascia with interrupted catgut sutures; the splint sutures through the muscle sheath remain untied.

circumscribed serous meningitis, and in not a few instances the principal indication for operation is persistent and intractable pain.

In matters of technique, local anæsthesia should be given preference whenever applicable, the X-ray report should be at hand, X-ray identification of an individual vertebra at the level of the cord lesion should have been made, the incision should be planned to include, at least, three vertebræ, and the dura should not be opened unless, from marked distention or from discoloration, there is reason to believe the bullet is within the dural sac. The various steps in the performance of a laminectomy are amply portrayed in the illustrations.

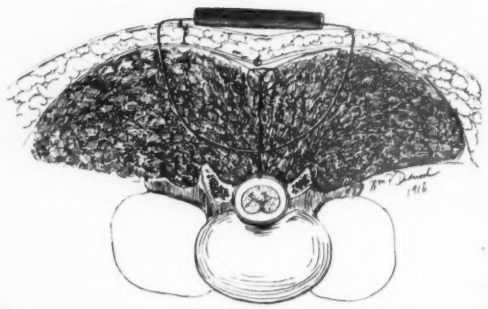


Fig. 17. A cross section of the wound showing the effect of the splint sutures in the obliteration of the intramuscular space.

Failing to find the bullet without the dura after a careful inspection on all sides, the dura must be opened and the search continued. After the removal of bullet or splinter of bone, lacerated or punctured wounds of the cord, and in some cases, severance of the roots may be revealed; but the futility of cord or root suture in the restoration of function is so well recognized that attempts at repair by suture, though occasionally practiced, are unwarranted. There seems to be a difference of opinion among surgeons with extensive military experience as to whether the dural incision should be closed in all cases. In deciding this question the surgeon must take into consideration two factors; one, the presence or absence of infection in the bullet tract and the other, the condition of the cord. As to the former, every precaution must be taken to guard against infection of the subarachnoid space and, if the wound be septic, closure of the dural incision is the safer course to pursue. In the absence of infection, should the cord be so swollen and œdematous that closure of the dural incision exerts undue pressure, a condition of rare occurrence, the dural incision may be left unsutured. On general principles, leaving the dural incision open as a routine practice should be condemned.

To avoid infection of the bladder and the inevitable ascending infection the catheter must not be used. Either a suprapubic cystotomy, which we have found so effective in civil practice, may be resorted to, or the bladder may be allowed to empty itself by overflow, a practice which has become popular in many of the War Zone hospitals.

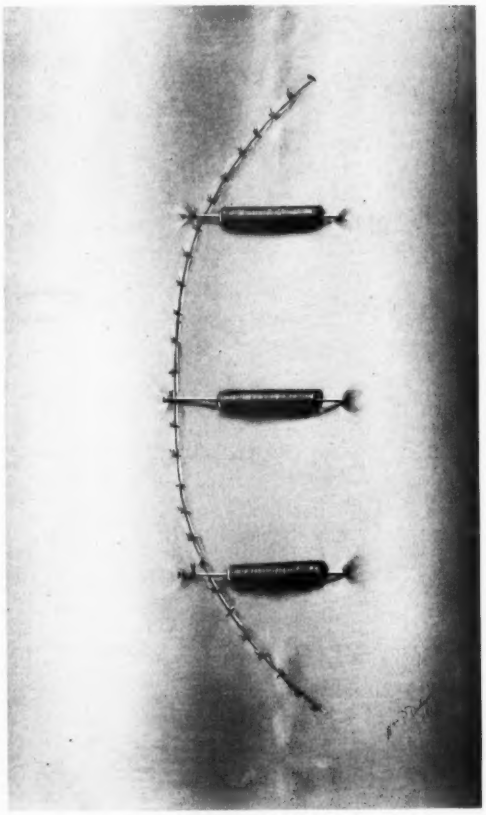


Fig. 18. Appearance of the wound after cutaneous interrupted sutures have been introduced and the splin-sutures, armed with rubber tubing, tied.

Enough has been said to show at least the complexity of the problems involved in the surgery of gunshot injuries to the spine. The determination for or against operation cannot be made here with the same facility as with gunshot injuries to the abdomen, where the physical signs are more sharply defined and may be elicited in a comparatively brief observation. Examinations for spinal injuries are time-consuming and must be oft repeated, and the segregation of these cases in a special hospital, on the staff of

which is included a corps of expert neurologists, would therefore seem to admit of no dispute. We have but to turn to the medical records of our own Civil War to find one of the most important contributions, the monograph "Gunshot Wounds and Other Injuries of Nerves" by Mitchell, Moorehouse and Keen, as the outcome of the co-operation between surgeon and neurologist.

Both in this classical monograph and in several historical papers written later, Weir Mitchell lays special emphasis on the fact that if, out of the general destruction and calamity of warfare, is to come any addition to this branch of medical science, any increase in our ability to relieve human suffering, it must come through concentrated minute study and observation on the part of both surgeon and neurologist, and from faithful and detailed records. When he tells us that he and Keen spent night after night, following upon days of toil, writing their own records without aid of clerk or stenographer, we realize what an example of service has been set us. We hope that we too in our generation, out of the calamity of this great war, may add our mite to the great healing science we serve.

OLD INJURIES OF THE SPINAL CORD[1]

By ALLEN B. KANAVEL, M.D., Chicago

SURGICAL intervention in injuries of the spine offers more hope for benefit than similar procedures in injuries of the skull. Both immediate and late operation in selected cases obtain results beyond what has been hoped for up to the present. These results are not to be secured, however, without painstaking attention to details of technique, preceded by careful neurologic diagnosis. It should be emphasized that the slightest trauma to the cord does great harm. In the brain owing to the interrelation of various groups of cells and their wide distribution, a fair amount of traumatization, even with destruction, may occur and the functions of the individual be unimpaired. In the cord, however, the bundles are so compact that the smallest actual injury is frequently followed by permanent impairment. Rough handling of the nervous tissue in an operative field is criminal on the part of the surgeon. The technical steps to be followed in exposing the cord have in the last few years become almost uniform in the hands of various neurologic surgeons. The removal of the spines and laminæ by the quickest possible procedures, the protection of the subarachnoid space from extravasation of blood, gentle handling of the cord, complete closure of the dura, obliteration of muscle space, and subsequent treatment without casts, are too well known to merit further discussion this evening. In my discussion of Dr. Frazier's paper, I shall confine myself to reporting briefly the results I have been able to obtain by operation on patients who have had spinal injury with involvement of neural tissue some months or years previously. These are grouped in two classes: those suffering from fracture, and those suffering from gunshot wounds. The results obtained by operation immediately after injury, while interesting, present an entirely different problem since the question always arises as to whether or not the patient might not have recovered without operation. In late operations, however, we have findings indicating definite involvement of the spinal cord or nerves.

Owing to the brief time allotted me in this discussion, the findings before operation will be presented by charts and a brief statement made as to the results of operation.

Case 1. Mr. P. L., age 49, referred by Dr. Hamill. Wesley Hospital. Fell backward 14 feet from ladder, July 31, 1914. Entered Wesley Hospital September 26. Unconscious for one-half hour after injury. Paralysis of legs and weakness of arms;

[1] Read before the Clinical Congress of Surgeons of North America, Chicago, October 22-26, 1917. Discussion of Dr. Frazier's paper.

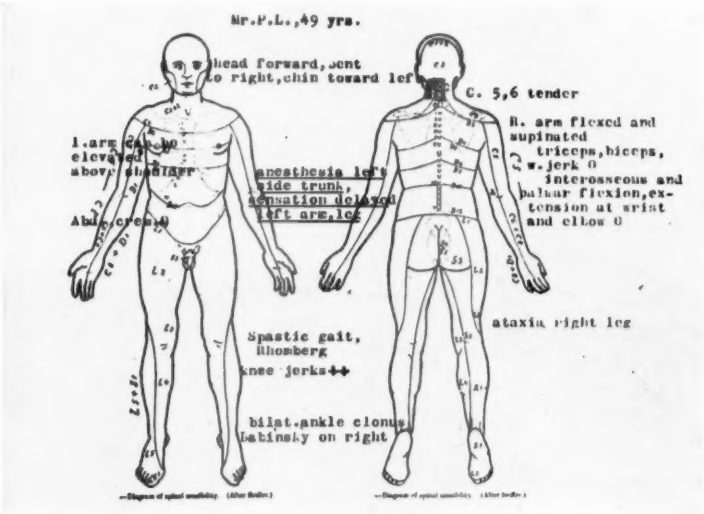

Mr.P.L.,49 yrs.
Head forward, bent to right, chin toward left
C. 5,6 tender
R. arm flexed and supinated
triceps, biceps, w. jerk 0
interosseous and palmar flexion, extension at wrist and elbow 0
Anesthesia left side trunk, sensation delayed left arm, leg
ataxia right leg
Spastic gait, Rhomberg
Knee jerks ++
bilat. ankle clonus
Babinsky on right

Fig. 1. Case 1. Findings on entrance.

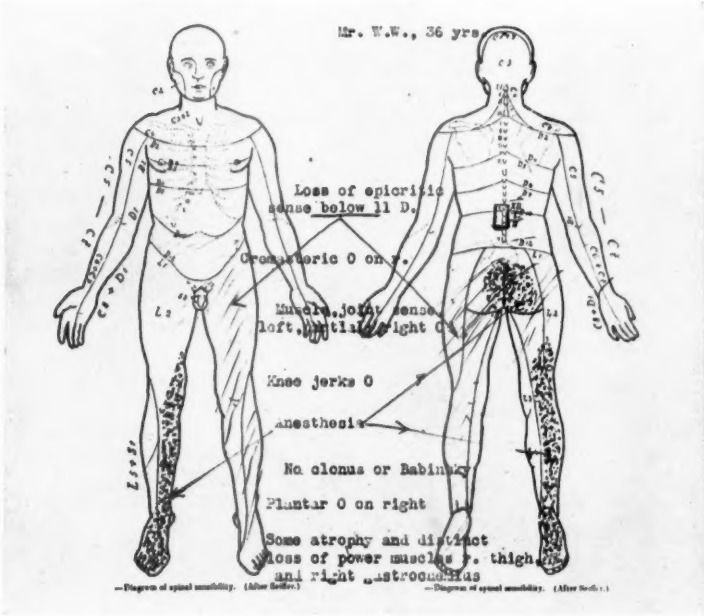

Mr. W.W., 36 yrs.
Loss of epicritic sense below 11 D.
Knee jerks 0
Plantar 0 on right
Some atrophy and distinct loss of power muscles r. thigh and right gastrocnemius

Fig. 2. Case 2. Findings on entrance.

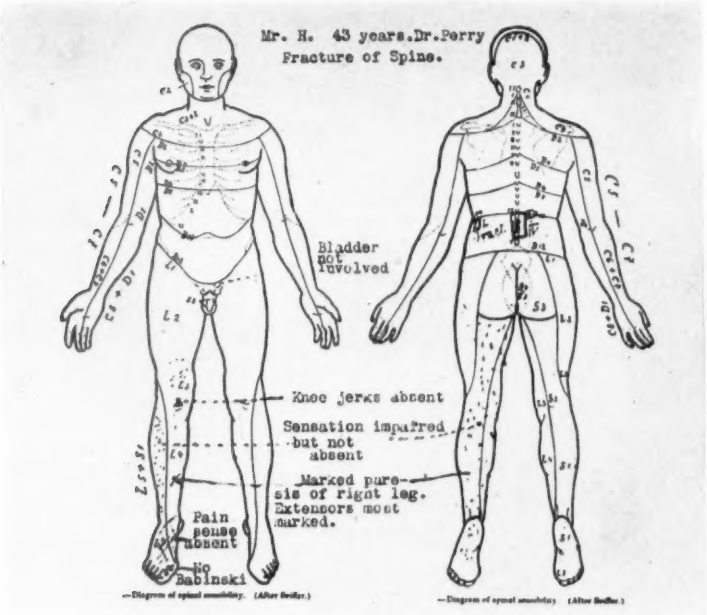


Fig. 3. Case 3. Findings on entrance.

6 days after fall became unable to use right arm. Could move both legs slightly. On entrance findings were as shown in Figure 1. Motion in right arm has improved during previous two weeks, but he is unable to pick up anything with it. Left arm weak. Unable to pass urine for few days before entrance. Occasional sensations of heat and cold across abdomen and in legs.

Operation September 29. Laminæ of the fourth, fifth, and sixth cervicals removed. Fracture of fifth cervical cord compressed by fourth cervical, not pulsating. After the excess fluid was allowed to escape and the inflammatory exudate was removed, the cord began to pulsate. Uneventful recovery.

Left hospital November 14, with no incontinence. July 1916, he was able to walk without support and to use arms and hands but some slight inco-ordination and weakness were present. Sensation had improved markedly although there was not a complete restoration. The patient has so far improved, however, that he holds a position as flagman.

CASE 2. W. W., age 36. Wesley Hospital. Referred by Dr. Mix. June 22, 1915, jumped 15 feet from a freight train. He was conscious for a few seconds. There was immediate loss of motor power and sensation below hips. Twenty-four hours later sensation began to return with motion of toes in left foot. Following the operation there were incontinence of urine, constipation, and entire loss of sexual control. He entered the hospital June 8, 1916, with findings as noted in Figure 2.

Operation June 9, 1916. Laminæ of the twelfth dorsal and first and second lumbar removed. The first lumbar vertebra was fractured and displaced forward. Chronic pachymengitis and leptomeningitis.

The patient recovered from the operation with a restoration of bladder function. There was some slight return of sensation and some improvement of motility. The patient is still a dependent and doubtless will never completely recover, although improvement continues.

CASE 3. Mr. H., age 43, referred by Dr. Perry. Struck by automobile, causing extreme flexion of the spine. Fracture of the second lumbar vertebra. He was unable to move right leg. Spasm about lumbar spine. At first there was a complete paralysis of all the muscles of right leg. Left leg, slight paralysis but could move leg. Tactile sensation slightly impaired. Pain sense absent over the dorsum of foot. Tendon reflexes at knee and heel absent in right; impaired in left. No Babinski.

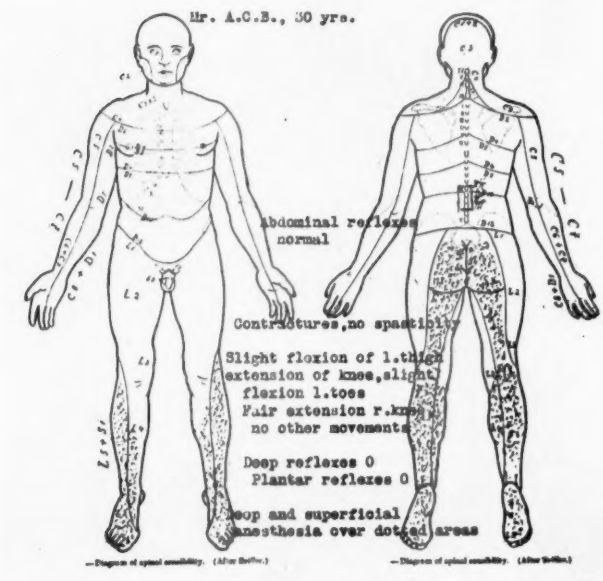


Fig. 4. Case 4. Findings on entrance.

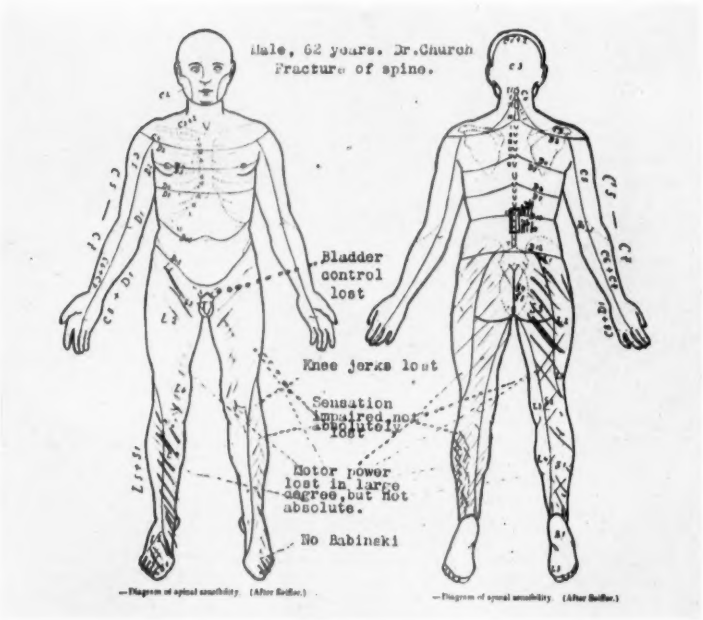

Male, 62 years. Dr. Church
Fracture of spine.
Bladder control lost
Knee jerks lost
Sensation impaired, not absolutely lost
Motor power lost in large degree, but not absolute.
No Babinski

Fig. 5. Case 5. Findings on entrance.

Cremasteric reflex present. Early bladder incontinence; now absent. Intestinal paresis marked for some days after injury. Extensor of right leg apparently atrophied to a considerable degree. Small bed-sore present on scrotum. Findings as shown in Figure 3.

Laminectomy on tenth day. Lamina of the second vertebra found fractured and body impinging on cord.

Paræsthesia which had been present disappeared at end of first week. Fourth week patient could walk with the aid of crutches. Sixth week, walked with cane up and down stairs. Apparently complete recovery.

CASE 4. Mr. A. C. B., age 30, referred by Dr. Hamill. Wesley Hospital. July 19, 1915, knocked down by auto and dragged 15 feet. Unconscious for two days. After regaining consciousness he was unable to move legs from hips down. Weight applied to feet, then plaster cast. Two weeks after injury was operated on at Grand Rapids, Michigan, but paralysis was not improved. No control of urine or bowels since accident. Large bed-sore present, November 23, 1915, when he entered the hospital. Findings as shown in Figure 4.

Operation, December 7. Laminæ of twelfth dorsal, and first, second, and third lumbar removed. Cord apparently destroyed; surrounded by fibrous tissue. Patient died ten days after operation, of acute pyelonephritis. Wound and meninges not infected.

CASE 5. H. G., male, age 62, farmer, referred by Dr. Church. Seventeen months before entering the hospital, the patient fell 15 feet from roof landing upon both feet, resulting in acute, sharp and excruciating pain in the lower part of the back. Elapsed into unconsciousness 40 minutes after the accident, lasting 2½ hours. Tingling, prickling, and numbness appeared over both legs followed by cramps, constipation, and urinary retention necessitating catheterization for 3½ weeks, when incontinence of urine (overflow) and involuntary bowel movements occurred and continued up to time of entrance. Sensory and motor changes persisted as shown in Figure 5.

Diagnosis: compression fracture of second lumbar vertebra.

Operation April 4, 1917. Laminectomy of twelfth dorsal, first, second and third lumbar.

Transplant of fat wrapped about nerves. Patient discharged in 40 days. Impairment of sensation distinctly less. Motor power undoubtedly improved. Bladder control restored. Patient markedly benefited by the operation.

The results in these cases clearly demonstrate that all old cases of fracture of the spine should be subjected to careful study as to the advisability of operation. Where the paralysis and loss of sensation are nearly complete with incontinence of urine, little is to be hoped for if the lesion is above the cauda, particularly if it is over the dorsolumbar reflex centers. In patients with a lesser degree of injury, more often if above the dorsolumbar centers and particularly if below them, operation should be considered most seriously. The cervical fractures are particularly prone to present hæmorrhage within the cord; consequently this should be remembered in making a decision as to operability. In my experience these cervical injuries even below the third cervical are particularly prone to fatal issue. In this connection I am reminded of three cervical fractures occurring on my service at the Cook County Hospital, all within three weeks; one of the fourth, and two of the fifth cervical vertebra. All were apparently in good condition for 24 hours and yet all died suddenly in the second 24 hours with increase of temperature and evidence of involvement of the medulla. Whether this result followed an œdema or hæmorrhage I do not know; but they emphasize the serious nature of these injuries. Undoubtedly the most favorable cases are those presenting fracture below the lower dorsal reflex centers. Here, of course, the lesion most often presents the great irregularity in its symptomatology associated with caudal lesion, yet were it nearly a complete involvement an early radical operation would hold out considerable hope for great relief and one would be inclined to urge it in all such cases.

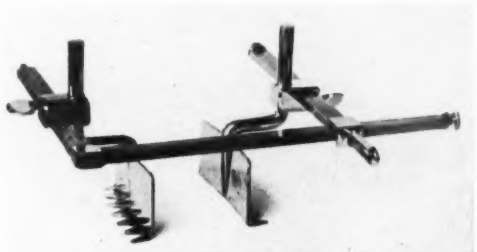


Fig. 6. Author's retractor for use in laminectomy. Note the toothed edge preventing slipping, the angle of the retractor blade handle to keep the retractor out of the field and the sliding of the handle up and down to accommodate it to the lumbar and dorsal curves.

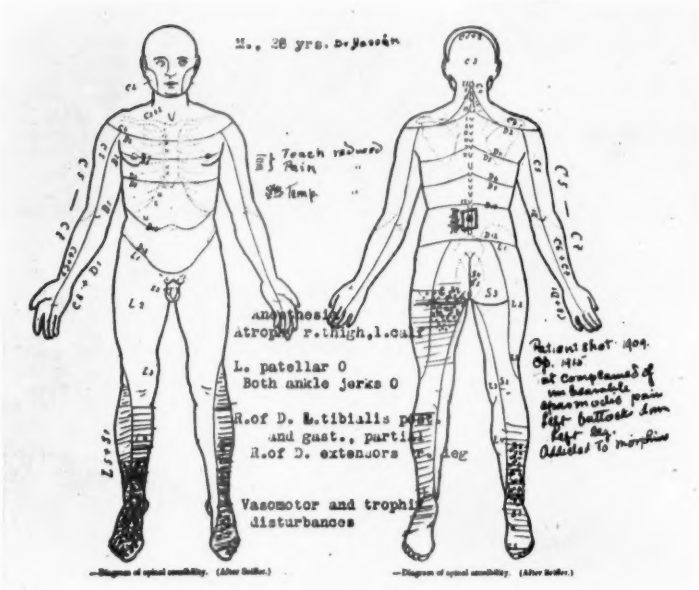


Fig. 7. Case 6. Findings on entrance.

One case not reported here owing to the fact that it has been so lately operated upon presented a restoration of bladder function after four years of incontinence.

In these old cases with bladder involvement one must always expect a pyelitis. From this, death occurred in my one fatality following laminectomy. One patient (W. W.) on the morning of the proposed operation developed a chill and a temperature of 105° necessitating delay in the operation and emphasizing that temperature and chill after operation may not be due to infection of the operative field.

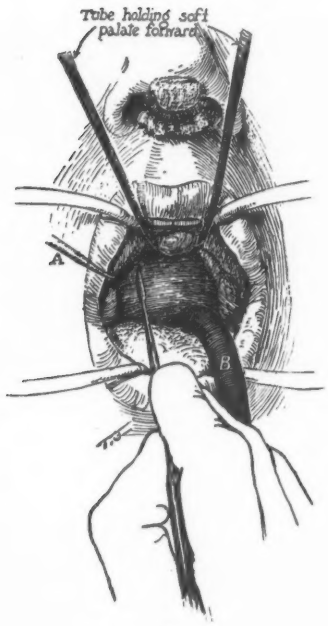
Fig. 8. Bullet in cauda equina removed after 6 years.

It would seem to be worthy of note that the pressure on the cord is most often not at the site of the fracture, but owing to the dislocation of the injured vertebra forward at the junction of the fractured vertebra with the uninjured vertebra below and at times above; consequently at operation care should be taken to remove the spines and laminæ of the sound vertebræ above and below the fracture.

Three patients with gunshot injury of the spinal cord have been observed. In one the bullet had undoubtedly destroyed the cord at the ninth dorsal vertebra and operation was contra-indicated. The other two cases have been reported elsewhere; the first by Dr. Hassin[1] and the second by myself.[2]

[1] Hassin. J. Am. M. Ass., 1916, lxvi, 1001.
[2] Kanavel. Surg. Clinics of Chicago, 1917, Apr., 361.

A.



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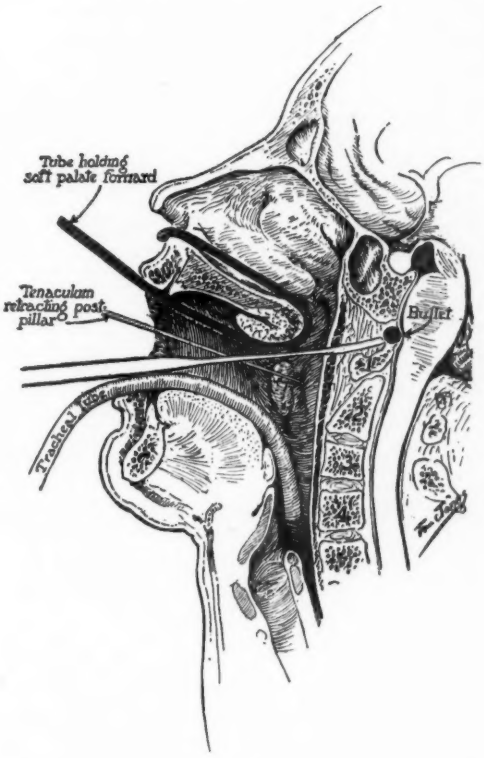

C.

Fig. 9. *A*. Location of the bullet between the atlas and the base of the skull. Note the groove on the atlas. The arrow indicates the course of the bullet.

B. Technique of removal of bullet, Case 7. Tube inserted in nose with gauze which protected the septum from pressure, the posterior pillar on the right side being hooked up and drawn forward.

C. Sagittal section of the vertebral column showing the position of the bullet.

The first was especially interesting because of the fact that the patient had been operated upon after the accident but the bullet had not been found. He came to me six years after the injury and the removal of the bullet relieved him completely of the intolerable pain which he had suffered for 6 years. The findings are shown in Figures 7 and 8.

In such cases and in those fractures where it is necessary to dissect out the nerves, it will be found advisable to use some type of magnifying glass so that the nerves may be dissected out of the scar tissue with great care. A pair of magnifying spectacles have proved satisfactory to me. In one patient (H. G.) a large pad of fat was transplanted with apparent success in and about the nerves to prevent scar-tissue contraction.

CASE 6. M., male, age 26. Cook County Hospital. Dr. Hassin. Shot in 1909. Bullet in spine. Immediately afterward paralysis in both lower extremities. Anæsthesia and loss of sphincter control. Loss of sexual control. Cystitis for two

years after accident. Came to Cook County Hospital complaining of pain in left lower extremity, weakness of legs, especially left foot.

Operation, September 24, 1915. Laminæ of second, third, and fourth lumbar vertebræ removed. Bullet at third lumbar. Two months after operation no pain. Gait normal. Calf measurements one inch greater. Sensation, reaction degeneration, and reflexes unchanged.

CASE 7. Master M., age 11, shot himself in September, 1916, with a 22-caliber bullet which entered the neck at the right of the midline, below the cricoid cartilage and lodged in front of the dura, between the base of the skull and the atlas just to the right of the midline. He suffered particularly from stiffness and soreness of the neck and occipital headache and inability to flex or extend the head. He could bend it laterally because of the action of the atlas on the axis, but he could not flex or extend it without great pain.

When I found that this bullet was located between the base of the skull and the atlas inside in the bony canal, the dangers of the operation seemed so great that I advised conservative treatment and sent him home. He came back in six weeks with exactly the same symptoms. It was evident that the action of the skull on the axis was such that he would continue to have this difficulty as long as the bullet remained in this position.

Operation was advised and performed by the following technique: Pharyngeal anæsthesia was given, the tongue retracted to the left, the soft palate raised by a rubber catheter passed through the nares and out the mouth (see Fig. 9) and an incision in front of the posterior pillar upon the right side made. The incision was carried down to the vertebra and the bullet could not be found in spite of my X-ray pictures. A wire was inserted over where the bullet was supposed to be. A flouroscopic examination was made and it was found that the wire was immediately above the bullet. I then realized that the missile was inside the spinal canal. With the rongeur a section of the atlas was removed and the bullet extracted from its position. The boy made an immediate and permanent recovery.

CHANGES IN TRIGONE DUE TO TUBERCULOSIS OF KIDNEY, URETER, AND BLADDER. BRIDGE FORMATION AND FLOATING TRIGONE

BY HUGH HAMPTON YOUNG, M.D., F.A.C.S., BALTIMORE
From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital

THE common changes which occur in and around the trigonal end of the ureter in cases of tuberculosis of the kidney are well known, but the three cases here recorded present conditions which I have not seen recorded in the literature, and which were novel to me, so that their recital here seems justified.

CASE 1. No. 3690. Invagination of trigone into ureteral orifice, due to traction by shortened ureter. I. L. Y., aged 42 years, was admitted March 31, 1914, complaining of kidney trouble. The family history was negative and the past history unimportant. Four years previously he had begun to have attacks of pain in the region of the right kidney, cloudy urine, and frequency of urination, accompanied by burning in the urethra. This condition lasted 4 months, after which he was apparently well for 10 months when there was a recurrence of the pain in the right side, which was sharp in character, came on at irregular intervals, did not radiate, but seemed to be accentuated by moving about. The urine was again cloudy, and occasionally slight chilly sensations accompanied by fever occurred.

About this time the patient had an attack of pain in the left side, followed by marked hæmaturia for 4 days. All of these symptoms cleared up in a week and he had no further trouble and felt very well until November, 1913 (16 months before admission), when, during an attack of "grippe," the pain in the right back returned and the urine became very purulent. This persisted up to the time of admission. The attacks of pain were quite frequent, occurring almost every day, were sharp and lancinating in character, and had never radiated from the right back, remaining localized to the region beneath the right costal margin near the spinal column. One month before admission he had attack of sharp pain

on the left side, exactly similar to those occurring almost daily on the right side. Following this he again passed blood for 4 days, as he had done 3 years previously, during the only other attack of pain in the left side which had occurred. There had been recent slight fevers, night sweats, and 35 pounds loss in weight. Urination, fairly normal.

Summary. The patient is apparently very ill. Appetite and digestion are poor. He is suffering from frequent attacks of pain under the right costal margin near the spinal column. The attacks are occasionally accompanied by chilly sensations, but no vomiting. He is accustomed to get up only once at night to void, and holds his urine for the normal time during the day. He has no hesitancy, no urgency, no difficulty nor pain on urination. The urine is very cloudy. Sexual desire is absent.

Examination. The patient is a pale, sallow, sick-looking man, having lost 35 pounds in weight. The right kidney is indistinctly palpable; apparently there is some tenderness in that region. On the left side the muscles are tense, and there is a palpable mass which reaches two fingers' breadth below the umbilicus and to the crest of the ilium; the internal edge is about two fingers' breadth to the left of the median line, and mass extends up beneath the ribs on the left side and well around into the left loin. It is quite fixed and it is evidently a much enlarged kidney; the surface is somewhat irregular and very tender.

Genitalia. No urethral discharge. Both testicles, epididymes, cords, and groins negative. *Rectal.* Prostate not enlarged, slightly indurated, moderately irregular and adherent, but not markedly changed. The right seminal vesicle is smooth, soft, elastic, not adherent; left seminal vesicle negative.

Cystoscopy. The catheter passes with ease and finds 20 cubic centimeters residual urine; the bladder capacity is 180 cubic centimeters on forced distention. The cystoscope meets slight obstruction in the deep urethra. The right ureter lies in a fairly normal looking ridge. The orifice and the bladder around appear quite normal. The urine, which comes out at fairly frequent intervals, is apparently clear. Starting from the right ureter and passing toward the left, the ligamentum interuretericum becomes progressively more and more pronounced, and is finally greatly elevated, the whole left corner of the trigone standing out as a wedge-shaped ridge of considerable prominence running into the left ureteral orifice. As the patient expires the corner of the trigone is drawn up into the ureter, as he inspires it descends at least one centimeter, but even on deep inspiration the ureteral orifice is still invaginated. As the patient lies on his back breathing, this prominent trigonal ridge slides back and forth in the ureteral orifice synchronously with the respiration. The ureteral orifice is held up as a prominent concave fold upon this ridge, in front and behind which is quite a deep pouch, probably 2 centimeters deep. The ureter is evidently on considerable tension, and the whole trigone is drawn toward the left, as shown in Mr. Broedel's drawing (Fig. 1), which was made from sketches taken by him at cystoscopy. Figure 2 is an ideal reconstruction made by Mr. Broedel from information gained by cystoscopy, combined with that obtained by examination of the ureter and kidney during and after operation. The ureteral orifice is evidently quite dilated, and contains within its lumen this muscular trigonal ridge. The mucous membrane is everywhere smooth, and there is very little injection of the vessels. The bladder itself is fairly normal, quite tender. In places there are small petechial red spots but no ulcers and no adherent mucus.

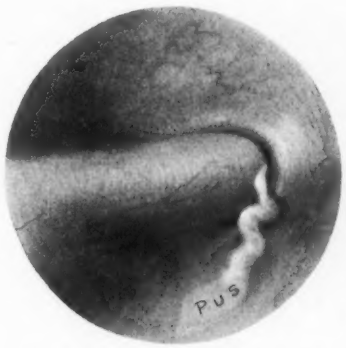

Fig. 1. Case 1. No. 3890. Cystoscopic view showing left end of interureteral ridge, markedly thickened and drawn upward, on account of traction by a thickened shortened ureter, causing invagination of the corner of the trigone and disappearance of the ureteral orifice. A stream of pus is seen coming from under the crescent shaped fold of mucous membrane, although the ureteral orifice is not visible. The thickened ureteral ridge has a to-and-fro piston-rod motion, synchronous with respiration.

Study of the prostatic orifice shows a slight rounding anteriorly, as if there was some contracture of the orifice. The right lateral lobe is not enlarged. The median portion of the prostate is slightly but definitely elevated and is continuous with the hypertrophied trigone, and the ridge running into the right ureter. The left lobe of the prostate is not intravesically hypertrophied. No stone, and no tumor present. No cellules or diverticula present. The bladder is not trabeculated. With the finger in the rectum and cystoscope in the urethra, palpation per rectum high up on the left side shows some induration, probably in the region, of the lower portion of the right ureter, but nothing very pronounced. The median portion of the prostate does not seem to be much enlarged. The trigone does not seem to be much thickened.

Urinalysis. The urine is slightly cloudy, amber, acid, albumin present, no sugar. Leucocytes, a few red blood corpuscles, no casts, a few cocci in pairs. April 5, 1916.

Ureteral catheterization. Pus is seen discharging from the left ureter but a catheter could not be

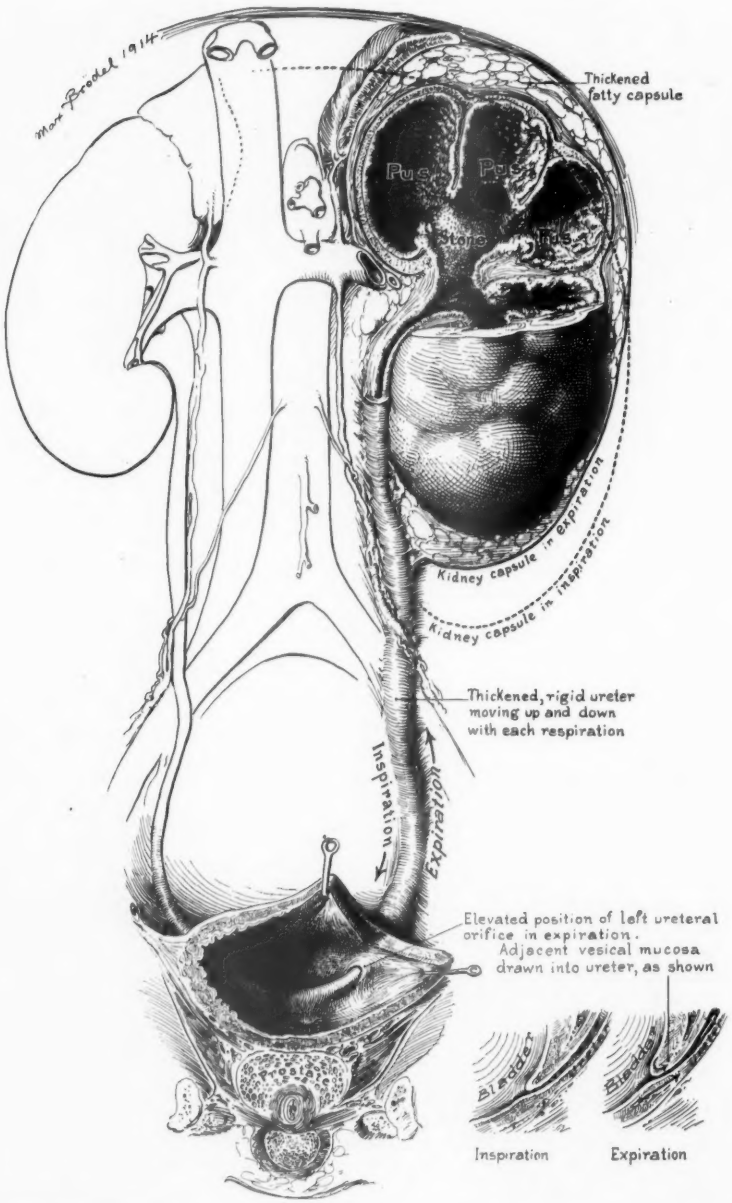

Fig. 2. Same case as Fig. 1. Reconstruction of bladder, ureter, and kidney made from information gained at cystoscopy and operation. Shows pus kidney with thickened inflammatory fatty capsule, adherent to diaphragm, and a thickened rigid ureter, making traction on corner of the trigone.

Fig. 3. Case 2. No. 5541. Showing remarkable similarity in cystoscopic views in Cases 1 and 2.

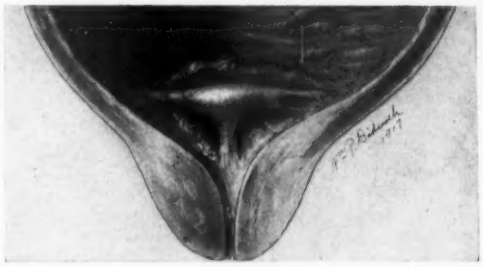

Fig. 4. Case 4. No. 1127. Before nephrectomy. Tuberculous cystitis with outward traction on ureteral ridges, producing prominent trigone and pouching, with undermining tuberculous ulceration, behind and on each side of the trigone.

inserted into the left ureter. The right ureter was catheterized but the catheter could be inserted only for a short distance and the cystoscope had to be left in the bladder for time of collection. The urine from the left kidney (if any) was collected transvesically with a catheter.

Right ureter. Phthalein appeared in 4 minutes; 12 per cent in 30 minutes. Microscopically there was no pus or organisms.

Transvesical. Voided 240 cubic centimeters at end of 30 minutes. Phthalein 10 per cent. Some urine from right side may have escaped around ureter catheter into bladder. Microscopic examination shows red blood corpuscle epithelial cells.

Operation by Young April 6, 1914; nephrectomy, left; there was a huge tuberculous kidney, which was densely adherent above. The fatty capsule was so adherent that it had to be removed with the kidney. The ureter was markedly indurated, and about 1 centimeter in diameter. It was freed and divided 2 or 3 inches below the renal pelvis. The pedicle, which was surrounded by very dense adhesions, was clamped and tied off with several catgut ligatures. The patient lost very little blood, was in excellent condition, and the kidney had not been torn into and no pus escaped. The wound was closed with two sutures (continuous) for the muscle and interrupted for the skin. Two small strips of gauze were brought out at the upper angle of the wound. (Subsequently result showed that drainage tubes should have been used, as a great deal of fluid accumulated and drainage tube had to be subsequently inserted.) The patient stood the operation well. Condition good.

The patient had a remarkably good convalescence, and was discharged from the hospital April 30. There were no complications of any sort. The wound healed nicely.

Cystoscopy. There is no residual urine. The bladder capacity is apparently fairly good. The cystoscope shows in the left half of the bladder an entirely different picture than seen before operation. The ureter lies in a hypertrophied ridge, which is much less prominent than before and there is no urine coming from it. The orifice looks a little more contracted than normal; the margins are a little rough and œdematous, but otherwise negative; the surrounding mucous membrane is quite negative. There is no moving of this corner of the trigone on respiration and no invagination, and peculiar to-and-fro movement of the hypertrophied ureteral ridge and corner of the trigone into the ureter, is to be seen now. The right ureter looks quite normal. The bladder is negative and apparently normal. The prostate orifice is apparently normal. The urine is clear with a trace of albumin. Microscopic examination shows a few leucocytes and red blood corpuscles; no bacteria. Specific gravity 1014.

October 30, 1914, a letter from Dr. W. T. Turlington, Fremont, N. C., states: "Our patient is at work and apparently well. I fully expected he would come back a corpse."

February 15, 1916. A letter from patient states: "I am doing all right."

September 16, 1916, another letter from patient states: "I have made steady progress. Urination is normal, there is no discomfort in bladder. My general health is good."

May 18, 1917, "I have no difficulty of urination. Void urine three or four times a day and once at night. There is no pain; urinary stream medium. General health excellent."

The result obtained in this case is indeed splendid.

Case 2. No. 5441. J. F. H., age 59, was admitted on November, 1916, complaining of cloudy urine and frequency of urination of two years' duration. History otherwise unimportant. General physical examination showed nothing of importance. Rectal examination negative.

Cystoscopy. There is a marked distortion of the trigone, the right end of the ureteral ridge being drawn upward and outward, and the left ureteral

Fig. 5. Same case as Fig. 4., eight months after nephrectomy. Showing trigone elevated above surrounding bladder mucosa like a suspension bridge, supported only at the three corners. The underlying ulceration has healed since nephrectomy. Cystoscope is in position, with fulgurating wire separating points of attachment of trigone.

orifice occupying a position almost in the mid-line. The right ureteral orifice is not visible, the ureteral ridge disappearing under a crescent-shaped fold of mucosa, as shown in the cystoscopic drawing, Fig. 3. With each inspiration a stream of pus is seen to come from under this fold of mucosa. The cystoscopic picture is quite similar to that described in Case 1, except that the to-and-fro piston-rod motion of the ureteral ridge, synchronous with respiration, is not present. The two cases both show marked drawing up of one corner of the trigone with pronounced thickening of the ureteral ridge, invagination of the ureteral ridge into the ureteral orifice, and pouching on both sides of the ureteral ridge. The similarity between the two cystoscopic views is shown by comparing Figs. 1 and 3.

Case 3. No. 4033. Tuberculous ulceration beneath elevated trigone, producing floating trigone. C. P. L., aged 42, was admitted June 14, 1916, complaining of bladder trouble. The onset was four years before admission with frequency of urination (every hour) associated with pain in the suprapubic region and burning in the urethra. In February, 1914, the patient consulted a urologist in New York, who found marked trigonitis and cystitis, and tuberculosis of the right kidney. Right nephrectomy was carried out. "In the specimen three small tuberculous foci were found."

This operation, the patient stated, was followed by no relief from vesical symptoms. He continued to suffer greatly with vesical pain and frequency of urination, voiding every 10 to 15 minutes, with marked burning pain in bladder and urethra; the urine was cloudy, and at times bloody. There were no symptoms at any time referable to the kidney or to the scrotal contents or groins. Sexual powers were impaired but ejaculation was fairly normal. He had lost 31 pounds.

Physical examination. The patient was well nourished. The heart, lungs and abdomen were negative. The nervous system was negative.

Genitalia. Slight induration of the epididymes, not suggestive of tuberculosis.

Fig. 6. Showing the trigonal musculature separate from, and superimposed upon, bladder musculature.

Rectal. Prostate slightly atrophic, moderately indurated and adherent; seminal vesicles slightly indurated.

Urinalysis. Cloudy, acid, no sugar, albumin present, many pus-cells, no tubercle bacilli found.

Cystoscopy. Residual urine 400 cubic centimeters. The cystoscope enters easily and shows a small median prostatic bar continuous with slightly thickened lateral lobes. The left corner of the trigone, the left ureteral ridge and orifice are fairly normal, but in the region of the right half of the trigone are two prominent ridges or bands of mucous membrane which extend from the site of the ureteral orifice down toward the prostatic orifice. External to and in front of this there is a deep pouch with a dirty granular wall. The anterior and left lateral wall shows chronic cystitis. Pre-operative diagnosis: Obstruction to urination due to a median bar, ulceration of the bladder, cystitis (tuberculous?), pathological bridges formed by ulceration beneath the trigone.

Operation by Young. Nitrous oxid, oxygen, ether. Suprapubic drainage. Excision with electrocautery of pathological bridges of vesical mucosa and muscles (trigone). Division of median prostatic bar with cautery. Thorough cauterization of ulcerated areas in bladder. Partial closure of bladder with tube drainage. Partial approximation of recti muscles and skin.

In the right half of the base of the bladder was a huge area in which the vesical mucosa was deeply ulcerated. The mucous membrane of the right half of the trigone alone remained intact in the shape of two strips about 5 centimeters thick which bridged the ulcerated pouch, and extended from the region of the right ureteral orifice (which could not be made out) to the margin of the prostatic orifice on the right side. The bridges were well vascularized and covered with smooth mucous

membrane, while beneath them there was a large area covered only by dirty necrotic granulations which occupied most of the right half of the bladder, and extended back on the posterior wall. The mucous membrane surrounding this large ulcerated area presented an irregular undermined edge. The left half of the trigone, ureteral ridge and orifice were fairly normal and the left half of the bladder was not ulcerated. The process was evidently an earlier stage of the process seen in Case 3, in which the ulcerated area has subsequently been covered with mucous membrane — leaving the bridge spanning the area.

With the electrocautery, the bridges or strips of mucous membrane were divided at each end and removed. The left half of the trigone was not disturbed with the electrocautery. The median prostatic bar was deeply cauterized; suprapubic drainage was provided; partial closure of wound.

Convalescence. Excellent recovery from narcosis. The Davis drainage apparatus[1] was applied and was very successful in keeping the patient dry. He was much more comfortable than before operation. On August 4 he still had a suprapubic fistula.

September 16, 1916, letter from patient states: "Epididymitis has developed since operation. Still void about every hour, wear a rubber urinal. Urine slow to start and drips afterward. The condition is improving, and my general health is good."

May 16, 1917, letter states that the patient reports that he has developed a tuberculous epididymitis and recently was subjected to operation — epididymectomy and seminal vesiculectomy. He still has great frequency of urination, having to void every few minutes, and there is a small urinary perineal fistula present. Catheter finds from 2 to 4 ounces residual urine. The general health is as good as it has been for two years.

Pathological report. Sections of tissue removed at operation show mucous membrane and muscle. There is extensive cellular infiltration and definite tubercles seen. Diagnosis: tuberculosis.

Comment. This was a very extensive case of genito-urinary tuberculosis which was improved temporarily by operation.

Case 4. No. 3565. Floating trigone, removed by division of attachments by fulguration. J. B., age 43, admitted May 10, 1913, complaining of frequent, difficult urination and hæmaturia. Family history negative for tuberculosis.

Past history negative.

Present illness. Eighteen months before admission he began to have frequency of urination. Some time later he had slight pain in the left side recurring occasionally, but never severe — only a "dull ache" in the left kidney region which radiates to the bladder at times. He had never passed a stone nor had he any colic. Nausea or vomiting had never been present. About a year before admission he began having hæmaturia which continued intermittently until admission; at times slightly, at others considerable. Six months later he began to have difficulty in urination which gradually increased. He had fever and night sweats for several months.

Summary. Urination every half hour, day and night; clots of blood at end of urination. Urgency quite marked; stream small; considerable difficulty in voiding.

Examination. Chest negative. The right kidney is not enlarged or tender. The left kidney is enlarged, palpable three fingers' breadth beneath the costal margin, and tender. It moves with respiration, and is smooth.

Genitalia negative.

Rectal examination. Rectum negative. The left lobe of the prostate is slightly enlarged, moderately indurated and adherent, but not nodular. The right lobe is about normal in size, smooth, only slightly firmer than normal. Both seminal vesicles are slightly indurated and adherent. There is moderate induration between the seminal vesicles.

Impression. Chronic prostatitis and seminal vesiculitis.

Cystoscopy. Catheter finds 40 cubic centimeters of residual urine. The bladder capacity is 80 cubic-centimeters. The cystoscope shows a remarkably prominent trigone with the bladder wall on each side and behind depressed like a pouch, as shown in Figure 4. The two corners of the trigone form prominent ridges which seem to be drawn upward and outward. The posterior limit of the trigone — ligamentum interureteric um — is also much elevated with a deed pouch behind it. The left ureteral orifice is at the end of the prominent ridge. It is red in color and surrounded by œdematous mucous membrane. The adjacent bladder wall is rough and granular, and this condition extends well out to the left. The right ureteral orifice and the right lateral wall of the bladder are similar to the left. The anterior wall of bladder is also irregularly ulcerated, and granular. The margin of the prostatic orifice is rough, irregular and œdematous, and the median portion is continuous with the elevated trigone.

Ureteral catheterization. Considerable difficulty in introducing catheters.

Right shows urine clear, amber; phthalein appeared in 3 minutes; excretion 28 per cent in 15 minutes; urea 1.4 per cent; no albumin. Microscopically, negative.

Left shows urine cloudy and pale; no phthalein excreted; no urea. Albumin — a heavy ring; pus-cells.

Urinalysis. Cloudy, acid, albumin moderate amount, no sugar. Microscopic: pus-cells and tubercle bacilli in large number.

Clinical impression. Tuberculosis of left kidney. Tuberculous cystitis with outward traction on ureteral ridges, producing prominent trigone. Tuberculous ulceration of pouches on each side of and behind trigone.

May 26, 1913. *Operation* by Young. *Nephrectomy*, left. Dense infiltration of fatty capsule

[1] Vesical drainage, historical review and presentation of a new apparatus. Davis, E. G. J. Am. M. Ass., 1916, lxvi, 1680.

encountered. The ureter is greatly thickened. The wound was closed with drainage.

Convalescence was satisfactory; discharged July 15, sinus still present, bladder improved.

Second admission February 26, 1914, the patient returns complaining of frequency and difficulty of urination. The wound is well healed, and he has improved greatly in health and strength, but still voids urine about every 1 to 2 hours night and day, with pain present at the beginning and end of urination. Nephrectomy did not apparently improve vesical symptoms.

Cystoscopy. Residual urine 100 cubic centimeters. Bladder capacity 150 cubic centimeters. Cystoscope enters easily and shows at once a remarkably bright area of tissue across the trigone, as shown in Fig. 5. This is completely covered with smooth mucous membrane, and well supplied with blood-vessels, and elevated well above the floor of the bladder like a suspension bridge, with two ends or supports on the left side (apparently just external to where the ureteral orifice would be), one support on the right side, terminating apparently in the right ureteral ridge, and the third running forward toward the median portion of the prostate, joining the bladder at a point 1 centimeter back of the prostatic orifice. The bladder beneath the bridge is covered with smooth mucous membrane. The body of the mass is at least 1 centimeter in diameter and spindle shaped. The two ends on the left side are small, one probably only 2 or 3 millimeters in diameter and the other tapering down to 4 or 5 millimeters. Cross section of each of these would be circular. It is evident that the bridge is the trigone which has become separated from the bladder except at the three corners, the new surface beneath the bridge is depressed, and has become covered with smooth new mucous membrane. The left ureteral orifice can be seen as a small slit which is not seen to functionate. The right ureteral orifice cannot be made out; it is probably obscured by the right end of the bridge. The bladder as a whole is congested, and in places on the anterior wall small ulcers are seen 2 or 3 millimeters in diameter with attached grayish-white exudate. The prostatic orifice shows no cleft anteriorly, the right lobe is normal; slightly irregular. The median portion is somewhat irregular and elevated, with the anterior edge of the bridge immediately behind it, the mucous membrane being quite rough.

March 15, 1914, operative cystoscopy. With rongeur cystoscope the anterior attachment of the "floating trigone" was grasped and torn away from its point of juncture behind the median portion of the prostate. Hæmorrhage prevented completion of procedure.

On March 24, 1914, fulguration was applied with an insulated wire through a catheterizing cystoscope at the two remaining points of attachment (at the outer corners of the trigone), as shown in Fig. 5.

March 21, 1914, cystoscopy showed the "floating trigone" to be free in the bladder; removed with small forceps through cystourethroscope by Dr. John T. Geraghty. April 4, 1914, cystoscopy shows the left ureter in its normal position, and just in front of it is seen the stump left where the trigonal bridge was divided by fulguration. Just in front of it is a little place covered by exudate which is probably the site of the small attachment of the bridge on the other side. The stump external to the right ureter is apparently about 2 millimeters high and 2 or 3 millimeters broad and 3 or 4 millimeters wide. The orifice cannot be seen owing to a mass of muco-pus in that region. The stump from which the trigonal bridge has been separated is visible. It is elevated only slightly above the bladder, and it is evidently a part of the ureteral ridge. It does not stand up so prominently as the stump of the left side. At the point of attachment anteriorly, there is a fairly prominent elevation just back of the median portion of the prostate; as shown, this is probably considerably magnified. The tip is covered with muco-pus. The floor of the bladder is obscured by muco-pus. The prostatic orifice is irregular, and the right lateral lobe seems to be a little more rounded than normal, and there is a small cleft between it and the median portion which is irregular and granular. The bladder itself is quite hyperæmic and generally red and granular. No stone or ulcer is seen.

Note.— Condition distinctly improved. Urination less difficult and frequent (patient discharged).

April 4, 1914, urinalysis shows pale, cloudy, albumin present; pus cells, a few bacilli, no tubercle, bacilli.

August 24, 1914, letter from patient states: "I am still gaining, but my bladder bothers me quite a lot. I urinate quite often and it hurts me."

November 10, 1914, another letter says: "I feel much better, but I still urinate about every two hours and have to strain to pass the last urine."

September 16, 1916, a letter from physician states: "Patient died July 19, 1916, of tuberculosis, but I feel that he lived much longer as a result of your operation."

These cases appear to me to represent three progressive stages:

1. Elevation of trigone (due to traction of a shortened tuberculous ureter) with pouch-formation behind and to the outer side (Cases 1 and 2).

2. Ulceration of depressed portions of bladder leading to complete undermining of elevated trigone which thus forms a bridge of healthy tissue (mucous membrane and trigonal muscle) across the new-formed tuberculous cavity (Case 3).

3. Healing (after nephrectomy) of the subtrigonal tuberculosis, leaving the separated trigone as a bridge with fairly healthy mucosa

beneath it (Case 4). It seems very evident that tuberculosis not only may produce marked thickening but also shortening of the ureter. This in turn may make traction upon the vesical end of the ureter and trigone, leading to invagination of the ureteral margin and elevation of the trigone on that side leaving the bladder depressed around it. Tubercle bacilli coming from the ureter naturally find easy lodgment in these vesical pouches while the greatly elevated ureteral ridge and trigone remain uninvolved. Ulceration in the pouches leads to undermining of the trigone from the bladder, a condition which the anatomists have shown us to be possible, as the trigone is separate from and superimposed on the bladder muscle in that region (Fig. 6). The movement of the ureter, synchronous with respiration (described in Case 1) is surely due to adhesions between the kidney and diaphragm: on expiration the diaphragm goes upward and the trigone is drawn upward with it by the adherent kidney and short thickened ureter. On inspiration the diaphragm and kidney allow the ureter and trigone to descend. The orifice, being surrounded by vesical mucosa remains more or less stationary, while the trigonal ridge plays back and forth like a piston-rod in the invaginated ureteral orifice. It is strange that this occurrence has never been noted before.

It is interesting to note the changes in micturition which occur as a result of these transformations of the trigone. Urination is apparently normal as long as the trigone is not detached, and the bladder has not become tuberculous. (*Vide* Case 1. Trigone much elevated, drawn to left by shortened ureter, deep pouches behind and externally. Micturition normal.)

When the trigone becomes pathologically dissected free from the bladder muscle, and even after new mucous membrane has formed beneath it, obstruction is present. (*Vide* Case 4 in which 100 cubic centimeters residual urine was present.) This was apparently not much improved by removal of the "floating trigone," as the patient continued to have residual urine and complained of having to strain to urinate nine months afterward. This brings up the question of the part taken by the trigone in the act of urination. It seems to me to indicate, that one function of the trigone is to pull open the internal sphincter of the bladder. I have long held to this view as I have frequently observed during cystoscopy, that if violent desire to urinate came on, the trigone would contract greatly and the prostatic orifice would open widely, the median (posterior) portion being apparently drawn backward by the muscle fibers which run from the trigone down into the posterior urethra, and which were seen to contract violently. The opening of the internal sphincter during urination will have to be viewed, therefore, not as an inhibitory action, as heretofore, but as the result of the contraction of the powerful trigonal muscle which passes in the form of an arc through a weaker muscle of circular shape (the vesical sphincter) and pulls it open when it contracts.

CONCLUSIONS

It is abundantly demonstrated by these cases that tuberculosis of the kidney may lead to great shortening of the ureter, resulting in traction on and marked elevation of the trigone, and invagination of the ureteral ridge into the ureter; that tuberculous ulceration may then produce an undermining of this elevated trigone and finally complete separation of trigone from the bladder beneath, except at the three corners (where the trigone is continuous with the ureteral muscle above and the urethral muscle below); that, after nephrectomy, healing of the vesical tuberculosis may leave this "trigonal bridge" with new mucous membrane beneath it except at the three corners where the "bridge" is attached and gets its blood supply.

THE EFFECT OF DICHLORAMINE-T CHLORINATED EUCALYPTOL SOLUTION ON THE PERITONEUM

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OUR attention has been drawn both by publication and by personal communication to the use of dichloramine-T chlorinated eucalyptol solutions in the peritoneum in infections from the appendix, fallopian tubes, and other organs. Lee and Furness (1) say, "Upon removal of the appendix (gangrenous and perforated) the 20 per cent solution has been dropped over all the visibly infected tissue." They follow this by placing a gauze drain saturated with the same strength solution in the cavity and dress the wound daily by applying the 20 per cent oil to the gauze wick and to the edges of the wound. Later, when the drain is removed, the cavity is filled with 5 per cent oil until granulations close the wound.

On the surgical service of the Lankenau Hospital, observations have led to the conclusion that very definite harm can be done by this method of treatment, and that, contrary to published opinions, skin irritation takes place, despite careful adherence to the principles of fresh undecomposed solutions, minimum dressings, avoidance of alcohol, water, and other substances likely to decompose the solution. Blood and exudate form a solid coagulum in the meshes of the gauze and interfere with drainage. The following brief notes will serve to illustrate these points:

A patient had a retrocæcal appendix abscess opened and the cavity gently mopped with a piece of gauze soaked in the 20 per cent solution, a small piece of selvage gauze soaked in the same strength solution was placed in the cavity. The operation was performed in the afternoon, and the following morning the patient's temperature reached an excessive height, where it remained for several days until the drain, which by this time had become as hard and stiff as a lead pencil, despite application of oil, was removed. Irrigation with Carrel-Dakin solution promptly led to the fall of temperature and general well-being of the patient.

A similar experience was gone through by a patient with a perforated gall-bladder and localized abscess in that region, except that the next morning, when high temperature was noticed, the drain, hard and stiff with clotted blood and exudate, was removed. After three days' irrigation with Carrel-Dakin solution, the wound was clean.

A very large appendix abscess cavity in another patient was treated similarly and when the hard, stiff clotted blood and exudate-covered gauze drain was removed, an opening in a loop of bowel, against which the gauze had rested, was discovered. Subsequent operation was necessary to close the fæcal fistula. Skin irritation was very apparent in these and several other cases, in which the oil was used. Odor of dressings and pus was not abolished; on the contrary, it seemed increased. With these observations in mind, it was decided to determine the effects of the oil, *per se*, on the peritoneum, and the following experiments were performed, and an attempt was made to estimate roughly its protective power in artificial infections of the peritoneum. Two strengths of solution were used, 20 per cent and 7½ per cent dichloramine-T chlorinated eucalyptol. (2). The peritoneal cavities of dogs were opened under aseptic conditions, and adhesions and other lesions eliminated by inspection; 5 cubic centimeters of the oil were introduced and the incisions closed. Unfortunately, the extremely cold weather at the time, led to the development of bronchopneumonia among some of the dogs, so that several of the deaths were probably due to this cause. We feel, however, that the results from the standpoint of our investigation were not altered in the main by this occurrence.

The 20 per cent solution was used in four animals, and their abdomens were opened

at different intervals with identical findings. The following is the protocol:

Dog. 5. Five cubic centimeters of 20 per cent oil were used. The dog died the second day. Autopsy showed a large amount of free fluid in the abdominal cavity with considerable fibrinous exudate over the intestines at the site of the wound. Many small patches of bronchopneumonia were present.

Dog. 3. Five cubic centimeters of 20 per cent oil were used. The dog was very sick for two days but gradually recovered in 3 to 4 days. The abdomen was opened in 14 days. There was distention and about 250 cubic centimeters of blood-stained fluid escaped. There was a dense hæmorrhagicofibrinous exudate with well begun organization matting the intestines together in a firm dense mass. This process was more or less limited to the neighborhood of the wound; the remainder of the abdominal cavity showed no solid exudate. No manipulation was done.

Dog. 4. Five cubic centimeters of 20 per cent oil were used. The findings were exactly similar to those for Dog. 3.

Dog. 10. Five cubic centimeters of 20 per cent oil were used. The abdomen was reopened on the ninth day. There were found many well organized fibrinous adhesions in the region of the incision. No free fluid was found. Many small patches of bronchopneumonia were present.

Dog 4 was autopsied 44 days after the introduction of oil, and dense fibrinous adhesions had replaced the fibrin, and the intestines were matted together in a solid mass. It is very evident from these experiments, that the 20 per cent solution caused marked inflammatory reactions, with the production of a hæmorrhagicofibrinous, in one animal, a fibrinous peritonitis, with later organization and the formation of dense adhesions. It was, therefore, far from harmless and non-irritating to the peritoneum of these dogs.

The protocol of those animals in which the 7½ per cent oil was used follows:

Dog 1. Five cubic centimeters of 7½ per cent oil were introduced. The dog made a good recovery. The abdomen was reopened in 13 days. The abdominal cavity was normal except for small adhesions of omentum to the under surface of the scar. No oil was detectable.

Dog 2. Five cubic centimeters of a 7½ per cent oil were introduced. The dog made a good recovery, with the same findings as in Dog 1.

Dog 6. Five cubic centimeters of 7½ per cent oil were introduced. The dog died in 14 days. Autopsy disclosed large patches of bronchopneumonia. The wound broke down to the muscles. In the neighborhood of the wound there was a small amount of fibrinopurulent exudate among coils of intestine. No trace of oil was detectable.

Dog 7. Reopened in 9 days after the introduction of five cubic centimeters of 7½ per cent oil. There was not a trace of exudate. adhesions or oil found.

Dog 9. Reopened in 21 days after the introduction of five cubic centimeters of 7½ per cent oil. There was not a trace of exudate adhesions or oil found.

Dog 11. Died on the fourth day after the introduction of five cubic centimeters of 7½ per cent oil. Autopsy disclosed bloody fluid and fibrinous exudate about the site of introduction of the oil. The oil could be detected both by sight and smell and apparently very little had disappeared.

Dog 12. Died on the fourth day after five cubic centimeters of 7½ per cent oil had been introduced into the abdominal cavity. The findings were the same as for Dog 11.

Dog 13. Died on the thirteenth day after the introduction of five cubic centimeters of 7½ per cent oil. Autopsy disclosed a general fibrinopurulent peritonitis with a collection of purulent fluid between the stomach and spleen. Immediately around the wound hæmorrhagic purulent exudate was present. There were patches of bronchopneumonia in both lungs. There was no trace of oil.

Dog 14. Reopened in five days after the introduction of five cubic centimeters of 7½ per cent oil. There were no adhesions or exudate present and no trace of oil.

Dog 15. Reopened in five days after the introduction of five cubic centimeters of 7½ per cent oil. No adhesions and no exudate were found. A few small hæmorrhagic spots were present in the omentum under the wound. There was no trace of the oil.

No oil was detected either by sight or smell in any.

Those dogs that died showed definite peritonitis, and while bronchopneumonia may have been the cause of death in two of the four, in two, no gross lesions other than the peritonitis were present. While in the majority, no apparent harm to the peritoneum was detected, the same hæmorrhagicofibrinous exudate, as was caused by the 20 per cent solution, was called forth in four, so that a strong possibility of harm is present in the use of the weaker, as well as the stronger, solution in the peritoneal cavity. The oil was still present on the fourth day in two of the animals, and the chlorine as well as the eucalyptol odor could be plainly detected.

A more difficult problem was to decide if it was of benefit in infection of the peritoneum and if, in the presence of infection, the oil had the same possibilities of harm. It was approached as follows:

The sigmoid was cut across and anastomosed end-to-end, without clamps. Fæces were allowed to contaminate the peritoneum, gauze sponges being used to make the soiling a minimum amount, localized to the vicinity of the anastomosis. Our experience with the 20 per cent oil led us to discard all thoughts of its use; so that, when the anastomosis was completed, the 7½ per cent solution was dropped over the infected field, the sponges were removed, and the abdominal wall closed. Two control animals were treated in an exactly similar way without the addition of oil.

The first control animal lived after a stormy convalesence; the second died in eight days, and a general fibrinopurulent peritonitis with much free fluid was found. Sloughing had occurred at the site of the anastomosis, and leakage was considerable. The following is the protocol of those in which oil was used after the anastomosis was completed:

Dog 2. Died on second day. Autopsy disclosed a general fibrinopurulent peritonitis, and a small leak in the anastomosis at the mesenteric attachment. There was no evidence of oil.

Dog 15. Died on the third day, and a general fibrinopurulent peritonitis was found.

Dog 14. Died on the eighth day. There were a large amount of free purulent fluid and a general fibrinopurulent peritonitis present.

Dog 9. Killed on the twenty-fifth day. The animal was very sick for six days, after which he recovered partially. The appetite and general condition remained poor. On the twentieth day he developed a diarrhœa and emaciation which was considerable, and rapidly grew extreme. His sufferings were so evident that he was killed with chloroform. At autopsy, evidences of a general fibrinopurulent peritonitis with organization were present, with an abscess containing about 100 cubic centimeters of pus in the pelvis, well walled off by dense adhesions. The anastomosis was tight.

These results with so many variable factors at work, must, of course, be interpreted very liberally, if at all; but, if an antiseptic has the virtues that this oil is said to have, the result should have been a sterilization of the area around the anastomosis, for the oil was applied on a healthy peritoneum infected by organisms which had not had time at all to obtain a foothold for growth and multiplication. Organisms did grow and multiply, however, and the result was an ordinary fibrinopurulent general peritonitis.

SUMMARY

The effect of solutions of 7½ per cent and 20 per cent dichloramine-T chlorinated eucalyptol on the healthy peritoneum of dogs was investigated. The same strength solutions were used on infected peritoneum to determine if infection would be inhibited or destroyed. Observations from the surgical service on the effect of the 20 per cent oil in the treatment of abscess cavities in the peritoneum are recorded.

CONCLUSION

The 20 per cent solution causes clotting of blood and exudate on gauze, and drains, and leads to interference with drainage and trauma. In the peritoneum of dogs, it causes a violent irritation with a hæmorrhagico-fibrinous exudation. The same results in the peritoneum of dogs are produced by the 7½ per cent in a certain percentage of cases. Both the 7½ per cent and the 20 per cent solutions are distinctly harmful to the peritoneum; the benefits are none.

Our thanks are expressed to Prof. E. T. Reichert, University of Pennsylvania, for the privilege of using the animal operating rooms and quarters in his department.

We express appreciation of the technical help of M. D. Sauter and H. G. Eilmann.

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THE THERAPEUTIC USE OF RADIUM IN GYNECOLOGY[1]

By JOHN G. CLARK, M.D., F.A.C.S., Philadelphia

I PURPOSE to review briefly the results obtained by radiotherapy in two types of gynecologic cases: first, those suffering from profuse or irregular uterine hæmorrhages induced by the smaller myomata, and the so-called myopathic hæmorrhages of benign origin arising from muscular or vascular changes in uteri of women approaching the climacterium; second, those comprising the cases of inoperable cancer of the cervix, vagina, and external generative organs. We have available for study 100 cases of each class, an unique coincidence, which rounds out the two series for easy percentage estimates. To my associate, Dr. F. E. Keene, I am deeply indebted for his careful analyses of the case histories and his accurate tracing of the after-results from which our conclusions have been drawn. Realizing that we were entering a new field, we have endeavored to keep free from an overenthusiastic optimism, an error to which one is liable in viewing the hopeless cancer case, which occasionally shows the most astounding improvement and to witness the almost invariable relief of hæmorrhagic symptoms in benign cases, hitherto subjected to hysterectomy.

THE USE OF RADIUM IN CASES OF BENIGN UTERINE HÆMORRHAGE

In presenting a remedy for the relief of symptoms and cure of cases of chronic metritis and small myoma uteri certain conditions must be fulfilled if it is to serve as a worthy competitor for myomectomy or hysterectomy. Briefly stated, the remedy must effectively cure, must be attended by as small risk or by even fewer hazards than accompany a well executed operation, and must be unattended by immediate or remote complications. Further, the cure must be permanent. To meet the well nigh ideal statistics of a well ordered series of operations in the hands of a skillful surgeon is no small task, for we all have reason to be proud of surgical accomplishments in this type of cases. No one has taken up the use of radium in the treatment of myopathic or myomatous conditions with a spirit of greater conservatism, indeed, with a spirit of skepticism, than we who have had a long series of excellent results accruing from surgical treatment in this field. We first tentatively experimented with radiation in patients during their menopausal years, but as our experience has grown we have treated younger individuals because of the successful issue in the climacteric cases.

As the question now stands—but we are still in the experimental stage—we use radium only in very light dosage in the treatment of young women in whom a tumor is not palpable, but who are suffering from a depleting flow at the periods. The flow diminishes as a rule to within normal limits but occasionally a permanent amenorrhœa results. The latter crisis can and will surely be precipitated by too large a dosage. Further, we do not employ and thus far see no valid reason for discarding an operation when the tumor is massive and by its presence is handicapping the function of adjacent organs by pressure. Large tumors are much more likely to be accompanied by inflammatory lesions, and there is always an element of doubt in the diagnosis. In such cases, we believe we serve the best professional ends in advising an abdominal operation, which permits a complete survey of the entire pathologic field, and the removal of such tissues as are necessary to restore our patient to health.

In young women in whom a myomectomy is possible we advise operation, for in these cases the uterus may be restored to normal and the ovaries are preserved. Briefly summarized we may say that we apply radium in the following groups of cases:

1. In large dosage, 50 milligrams for 24 hours, in women suffering with myopathic hæmorrhage or menorrhagia from myoma, in women over 40 years of age. In such cases we expect to bring on the menopause, and in practically all we are successful.

[1] President's address, delivered before the Clinical Congress of Surgeons of North America, Chicago, October 22–26, 1917.

2. In smaller dosage, 25 to 50 milligrams for from 3 to 8 hours in young women with excessive menses incident to myopathic changes, in very small myomata, in polypoid endometritis, and in those cases of irregular and profuse bleeding attributed to excessive functional activity of the ovaries.

We do not employ radium—

1. When the tumors are larger than a 3 to 5 months' pregnant uterus, or

2. In a young woman with a single myoma which may be removed by myomectomy.

We have now completed a series of 100 cases, all of which are available for statistical study. They are divided as follows:

Myoma	60
Chronic metritis	36
Polypoid endometritis	3
Cervical stump	1
	100

This series of 100 cases comprises patients who have been treated for uterine hæmorrhage of myomatous or myopathic origin. In no case was the tumor of large size, and in each the only symptom was excessive bleeding.

Technique of application. In every case a preliminary curettage was performed and the curettings examined to eliminate the possibility of carcinoma of the fundus. The radium, protected by platinum and rubber, was inserted to the fundus of the uterus, where it remained from eight to thirty hours. In by far the larger number of cases the time of application was twenty-four hours, and the amount of radium employed was 50 milligrams. The patients were discharged from the hospital in three to five days after operation. In the light of our review of cases we are inclined to reduce the dosage to 50 milligrams for twelve instead of twenty-four hours, believing that we will serve an equally satisfactory purpose with possibly fewer menopausal manifestations in some cases.

Results. Nitrous oxid anæsthesia is usually employed, and the discomfort of the patient is minimal. The shorter stay in the hospital, with practically no lingering sequelæ, is a large factor in hospital economics and favors quick return to working efficiency on the part of the patient. The postoperative convalescence is so nearly negative as to make it in no way comparable in danger or possible sequelæ to that of even the most ideal abdominal operation. As in the cancer cases, nausea and vomiting followed, lasting one or two days in only 25 and were absent in 58 instances. In a percentage of these cases the preliminary morphinization in the gas administration may have been responsible for these symptoms. Occasionally there was slight elevation of temperature, and in one instance 103° F. was reached. Only very occasionally was the convalescence marked by disagreeable symptoms.

We have obtained successful results in all but two cases. Five patients were between 17 and 25 years of age; in three of these the profuse menorrhagia has been reduced to a normal flow. There were 5 cases between 25 and 30 years of age, 13 between 30 and 35, years, 16 between 35 and 40, and 61 over 40 years. In all except two cases the periods have entirely ceased for intervals varying from two to nineteen months. Amenorrhœa may immediately follow the application of radium; there may be one or at most two scanty periods, or slight, irregular bleeding may occur for a few weeks before the permanent amenorrhœa is established. In several cases a scanty flow recurred after several months but this was again followed by amenorrhœa.

We have been interested in the action of radium in its effects on leucorrhœa. Our results show that, in the majority of cases, a yellowish discharge follows its application. Rarely, a profuse discharge may be present for a few weeks, but is not permanent. Nineteen of our patients gave a history of profuse leucorrhœa preceding radiation, which was entirely relieved by the treatment. In the relief of this symptom we have been agreeably surprised, since it seemed logical to assume that the changes produced in the endometrium and uterine blood-vessels might lead to a permanent and troublesome discharge.

Abdominal or pelvic pain has followed in 30 cases immediately after radiation, lasting, however, but a day or two. It is of interest to note that varying symptoms of the menopause, between slight and severe, have

SUMMARY OF RESULTS FROM THE USE OF RADIUM IN MYOPATHIC HÆMORRHAGE

Pathologic conditions	
Myoma	60
Chronic metritis	36
Polypoid endometritis	3
Cervical stump	1
	100
Age of patients	
17–20	2
20–25	3
25–30	5
30–35	13
35–40	16
40–45	28
45–50	23
50–55	10
	100
Influence on periods	
Immediate cessation	40
One period	18
Two or more periods	23
Return to normal and regular	15
No relief	2
Not stated	2
	100
Return of bleeding	
None	74
To normal after months of cessation	4
Once or twice only, then amenorrhœa	1
Profuse	1

HISTORY OF PATIENT AFTER APPLICATION OF RADIUM

Leucorrhœa	
None	44
Profuse with complete cessation	19
Slight	26
Cured by radium	5
Not stated	6
	100
Pain	
Absent	64
Present	30
Not stated	6
	100
Nausea and vomiting	
None	58
Present	25
Not stated	17
	100
Complications	
Present (pyometra)	1
None	97
Subsequent operation necessary	2
	100
Menopausal symptoms (according to age)	
17–20	1
20–25	1
25–30	1
30–35	8
35–40	8
40–45	19
45–50	10
50–55	5
	53
None	37
Not stated	10
	100

developed in 53 cases and have been absent in 37.

Only two unsuccessful results occurred: In the first, a case of chronic pelvic inflammatory disease, the patient's chief complaint was excessive and irregular menstruation. This case was diagnosed incorrectly as one a myopathic hæmorrhage, and as a result of the operative manipulation there was a recurrence of the old process, and two days after the application symptoms of acute pelvic peritonitis developed. An abdominal operation a few weeks later revealed an old infection with a superadded acute process.

In a second case the radium failed completely after two 50 milligram applications of 24 hours each in the presence of multiple myomata. When the uterus was removed, no visible effects of the radium upon the tumors or the ovaries could be detected either macroscopically or microscopically.

Conclusions. Radium is the treatment of choice in all cases of small, uncomplicated myomata, in which the only symptom is hæmorrhage. In these as well as in cases of myopathic hæmorrhage, almost 100 per cent cure may be expected. Sufficient dosage will produce complete and permanent amenorrhœa. In young women radium should be used with the greatest caution, since its application may be followed by a premature menopause. If other measures have failed in women under 30 years of age, radium may be employed, but in small dosage. Irregular bleeding due to pelvic inflammatory disease, tumors of large size or tumors of any size complicated by disease of the adnexa or surrounding structures, as well as single myomata in young women, are to be treated by appropriate operation and not by the application of radium. In no case of uterine bleeding should

radium be used without a preliminary curettage and microscopic examination of the curettings by a competent pathologist. Radium is applied at the same sitting as the curettage. In properly selected cases the immediate convalescence is uneventful and restoration to health is complete. Pelvic pain rarely occurs, and as a rule is of but a few days' duration. In the exceptional case, leucorrhœa follows the application of radium, but this is not permanent. Not infrequently radium has cured or diminished a discharge which was present before the remedy was applied.

THE USE OF RADIUM IN CANCER OF THE FEMALE GENERATIVE ORGANS

The lapse of time since we began the use of radium for cancer of the female genito-urinary system does not permit us as yet to regard it as an approved curative remedy, for our period of observation has extended over only three years, and the five-year test has not been passed. While, therefore, we must hold in abeyance any forecast as to ultimate results, our series of 100 cases nevertheless justifies us in estimating with great assurance the excellent palliative effects of radium. Before the advent of radium in the treatment of cancer of the cervix, we were constantly passing in clinical review large numbers of cases, among which only the occasional one was amenable to surgical measures; the others, upon being classed as inoperable, dropped into the hopeless discard and frequently did not appear even in our card indexes. A very few only of the latter class ever reached the hospital ward, for beds could not be utilized for this hopeless class of patients. Because of this casual treatment of these patients, we did not realize the extraordinarily large disproportion between the operable and inoperable cases, and in former years I offered my small series of radical operations for cervical cancer with a puzzled query, for if cancer was so frequent as was constantly asserted, why was not a larger number of operable cases being admitted to our wards?

In view of our more recent experience the answer comes with overwhelming force, and a surgical optimism, never enthusiastic, is now reduced to even a lower degree in the face of these discouraging figures, for while by the more radical method we operated upon only about 60 cases in 10 years, or an average of about six annually, we now estimate that we were turning away during the same decade at least 300 as hopeless. A basis for this assertion is laid upon the statement that during the last three years we have refused no patient, regardless of the extent of the growth, and giving all the possible benefits of radium, 100 having been admitted to the hospital. Combined operative statistics show that even in the selected cases for a radical hysterectomy, the primary surgical mortality will seldom fall below 10 per cent; that the disabling sequelæ are numerous and serious, and that in the end, under average skill, at least 66 2/3 per cent will die from a recurrence. We have, therefore, no reason to boast of epoch-making strides in the surgery of cancer of the uterus. Because this minimum salvage is the best that has been obtained by any other means of treatment, we still strongly adhere to the dictum that when the case is within surgical bounds, it should be treated by radical surgical measures. However, the remarkable palliative results following radiation in cases of inoperable cancer of the cervix have modified our viewpoint as to the cases which fall within the elective surgical class, for our former rule was: when in doubt as to the extent of the growth, operate; but we now reverse the policy, and in these cases we employ radium. Under this restrictive policy, our percentage of operative cases has shrunken, but we trust that under this conservative elective policy, better curative results from a radical hysterectomy will be secured in the future. We justify this conservative attitude by the assertion that in 100 inoperable cases treated, local healing has occurred in 52 per cent. This does not mean, however, that all of these 52 patients are alive, for several are dead of metastasis but without return of the local cervical process primarily destroyed by the radium. Even though the patient died from the secondary invasion, this is a remarkable showing as to palliative results, exceeding in our experience

all previous remedies, and we trust that several in our service will survive the five-year test.

One of the terrifying symptoms for the patient and her family is the more or less massive vaginal hæmorrhages. Of our 100 cases, 60 were completely relieved of this symptom. There was a recurrence of hæmorrhage in 10, and in only 4 was it uninfluenced. Vaginal discharge other than hæmorrhage was checked in 51, uninfluenced in 15. Of those suffering pain, 23 were relieved and 14 were not relieved. In some cases the relief of pain was only temporary, varying from a few days to a month or more.

A few surgeons have advocated the use of radium preliminary to hysterectomy. From this view we are radical dissenters, for it hardly appears conceivable that a remedy which works effectively for at least 2 centimeters from its point of application can be improved upon by a surgeon's knife, limited by such insuperable barriers as the bladder in front, the rectum posteriorly, and the ureters and pelvic vessels laterally. We, therefore, adhere strictly to one rule; namely, never to attempt an operation on any case that has been healed locally by radium. It appears to us a most unwise surgical policy to subject a patient to the hazards of a radical operation, rendered more dangerous by the dense cicatricial tissue which forms in the wake of a successful radium application, in what we believe to be a fatuous attempt to secure still more lasting results. Indeed, we are inclined to the view that under such manipulation nests of degenerating cancer cells enclosed in a sarcophagus of dense connective tissue may actually be liberated and thus render abortive an otherwise good palliative result.

Radium, as is shown in our series of cases, is by no means an infallible panacea for cancer. There is no way of determining which case will be benefited by its use. There is, beyond doubt, a certain percentage, as estimated by our observation, in which cancerous growths are not retarded by radiotherapy; indeed, in an occasional case it would appear that there is a positive acceleration of new-growth. That many cases show an astounding improvement with local disappearance of the ulceration cannot be gainsaid. In our series, several instances occurred in which the results achieved were so remarkable as to be almost incredible. Doubtless in some of these cases the fire is but smouldering, and will break out sooner or later with renewed violence, as several of our cases have proved, but upon the whole this treatment yields today, the least highly encouraging palliative results and we trust that permanent results will follow in a definite percentage of otherwise hopeless cases.

In the discussion of cancer cases the question of hospital economics must not be lost sight of. The length of stay in the hospital following a radical operation will average at least three weeks; whereas after the application of radium not more than three days will be required. When complications arise after radical operations they are usually serious, entailing much suffering. Such patients, on returning home, are likely to remain semi-invalids for several weeks or months, and when, as is frequently the case, there is a rapid continuation of the disease, they become a heavy burden to a poor family. In the comparison of statistics, this difference between the two classes of patients is greatly in favor of those treated by radium, a fact that tends to incline us strongly to the use of radium in border-line cases, which we formerly subjected to a radical operation.

Removal of the uterus in cases of cancer of the fundus has yielded such good results that we do not feel justified in taking any chances with radium, even in the border-line suspects, except in those where there is a serious surgical contra-indication. In our series of 100 cases, only four of carcinoma of the fundus were thus treated. *Our surgical attitudes toward the cervical and fundal growths are diametrically opposite. In border-line cases of cancer of the cervix we invariably employ radium. In advanced cases of cancer of the fundus we invariably perform a hysterectomy.*

A pessimistic view dominates our outlook in the surgical treatment of the cervical growths, if the pathologic process is at all advanced, whereas fundal growths may be viewed with a cheerful optimism even when the cancerous process is extensive. As a palliative agent,

RADIUM IN INOPERABLE CANCER OF CERVIX, VAGINA, AND URETHRA — SUMMARY

Diagnosis	
Carcinoma of cervix	74
Carcinoma of fundus	4
Carcinoma of vagina	7
Recurrent	10
Urethra	3
Chorio-epithelioma	2
	100
Age of patients	
20–30	4
30–35	2
35–40	6
40–45	11
45–50	17
50–55	22
55–60	13
60–70	19
70–80	6
	100
History of patient after application of radium —	
Hæmorrhage	
Complete relief	60
Recurrence	10
Uninfluenced	4
Not stated	15
Leucorrhœa	
Checked	51
Uninfluenced	15
Not stated	23
Pain	
Relieved	23
Not relieved	14
Not stated	52
Fistulæ	
Rectovaginal	4
Vesicovaginal	4
Local healing	52
No effect on growth	8
Hastened growth	2
Immediate untoward result	0
Stay in hospital — average 3 days	
Patients not traced	2
Too recent to report	9

RESULTS

DIED		ALIVE	
2– 4 months	7	2– 4 months	7
4– 6 months	6	4– 6 months	8
6– 8 months	7	6– 8 months	6
8–10 months	5	8–10 months	6
10–12 months	0	10–12 months	9
12–14 months	3	12–14 months	6
14–18 months	3	14–18 months	6
18–22 months	0	18–22 months	2
22–26 months	1	22–26 months	1
26–28 months	0	26–28 months	1
28–30 months	0	28–30 months	3
	32		55

Died few days after leaving hospital from heart failure	1
Died (time not stated)	1
Not traced	2
Too recent to report	9

we may assert with full assurance that we have never obtained results with any other method that have even approached in beneficence those secured by radiotherapy. The treatment is simple and entails no distress to the patient, and the results in checking hæmorrhage are immediate and in a very large number of cases this symptom never returns even in the fatal cases. Because of the well-nigh miraculous action of radium in the occasional case, there is danger of unbridled optimism and no one should let the occasional astounding result cloud his vision when it comes to a judicious consideration as to the best procedure in a large series of cases.

CONCLUSIONS

1. As a palliative remedy, radium is the treatment par excellence in inoperable cases of cancer of the cervix.

2. In border-line cases in which formerly we accepted the grave risks of an operation in the hope of eradicating the disease, we now employ radium, but in the certainly operable class we still advocate a radical operation.

3. In cancer of the fundus, even when far advanced, we perform a hysterectomy, resorting to radiotherapy only in the face of grave operative contra-indications.

4. As yet we claim no cures, but, based upon the observation of a considerable number of inoperable cases which have remained locally healed from one to three years, we venture the hope that the quinquennial test will find several survivors.

In this brief summary we have attempted to give a fair and unbiased statement of the benefits, limitations, and dangers of radiotherapy in gynecology. Our conclusion of today may be considerably changed by our experience of tomorrow, for this therapeutic endeavor is still in the period of probation, but our experience thus far proves with great assurance that the benefits of radiation are so great that no well ordered clinic can do the best work without it. In our experience 100 milligrams have been sufficient to serve a most satisfactory purpose in gynecologic practice.

RADIUM IN UTERINE CANCER[1]

By HAROLD BAILEY, M.D., F.A.C.S., New York

RADIUM has proved to be of great value in the treatment of uterine cancer of the inoperable type. It not only ameliorates the symptoms, but in many cases the entire process comes to a standstill with few or no clinical evidences of the disease remaining. Those who have been applying the substance with the usual technique scarcely doubt that it causes a disappearance of the tumor tissue which is in close proximity to the applicator. Notwithstanding, he would be an unwise man who would advise its use in the operable case, even when the cancer involves but one cervical lip and appears to be only a local disease. Why is this so? The answer is that the effect of the rays is not under the control of the user. Small doses of the radium may be safe but they do not reach the outposts of the disease; on the other hand, large doses may destroy all of the cancer but much damage is also done to the normal tissues.

Reports from various clinics show that the inoperable cases have a rate of cure of 15 to 25 per cent. The inference is that treated by the same technique the operable cases would show a rate of cure that would be very high. Howard Kelly has prophesied that eventually the cure of the operable class will be raised to 75 per cent by radium and operation.

I believe that it is only a question of improvement in technique, so that the entire pelvis may be radiated effectively without damage to the normal tissues, when all operable cases of cancer of the cervix will be treated with radium. At present even preoperative treatment is not justified because of the difficulties in removing the organ from the inflamed pelvis.

The justification for the use of radium in uterine cancer at present lies not in the fact that a certain proportion of the cases will be cured, but rather that in inoperable cancer the patient has but a short time to live and the damage to the normal tissues is but an incident and may be discounted in the attempt to obtain a permanent retrogression.

After ten years, the last four very active ones, in which experience has been gained in the use of radium in deep-seated work, it is time that the technique be so standardized that the treatment of cervical cancers may be conducted without injury to the normal tissue or the hollow viscera immediately surrounding the affected part.

Variation in the dosage as advised by the leaders of the different clinics extends from 50 milligrams of the salt to 1000 or even 1500 millicuries of the emanation. The length of time of the application receives so little consideration that it usually depends on convenience, that of the half or full day being usually favored. Inside the body — the vagina or the uterus — distance is seldom taken into account. The more or less mythical "extraordinary resistance of the vaginal mucous membrane" is relied upon, and unknown or forgotten are the distance factors of safety demonstrated daily by those who use radium upon the surface of the body.

Sometimes week after week reapplication of the radium is made to the very same area that was originally treated, in the hope that in some miraculous manner the rays will exert their curative influence at a farther distance and yet do no harm to the nearby tissue. With the attention riveted to the local lesion, it has not occurred to many that there are paths for directing the rays to the affected part other than through the vagina. Little heed was paid to cross-raying until the treatment of fibroids made it necessary.

The thickness of the metal filter of lead or platinum is usually standard at 1 or 2 millimeters in all directions. That the side of the filter away from the lesion might be considerably thicker has not been made an important item in the technique except by Kelly and Burnam who use the lead cup or layer of beaten gold to cover the back of the capsule.

Furthermore, the treatment of the far

[1]Read before the American Gynecological Society, Pittsburgh, May, 1917.

advanced postoperative and inoperable cases where the vaginal walls and the rectum or the bladder or both are involved, should cease. It is not only a waste of time but it actually does harm to the patient in making her remaining days more painful. Merely palliative treatment of this class is spoken of, but it is not evident in what the palliation lies unless it is the lessening of the discharge, which relief at most is very temporary.

Until these faults (of which, perhaps, none of us has been guiltless) are remedied, radium can hardly fill a field of usefulness except in inoperable cancer.

RADIUM TREATMENT OF UTERINE CANCER AT THE MEMORIAL HOSPITAL

At the Memorial Hospital, New York, there have been 120 cases of uterine cancer under radium treatment during a period of two and one-fourth years, from January 1915 to May 1, 1917. These cases have been on the service of Dr. George H. Mallett, to whom I am indebted for many courtesies.

Owing to the beneficence of Dr. James Douglas, the hospital has had a steadily increasing supply of radium so that it now possesses over 2.5 grams.

The hospital has a Physical Department, formerly under the charge of Dr. George Bosworth and now under that of Mr. G. Failla, and I wish here to express my appreciation for their diligence and patience in preparing the applicators and for the many useful suggestions that they have made.

All of the work has been with the emanation. It permits of a more accurate application because of the small size of the containers, and it represents the full ray strength of the metal. A millicurie of the emanation is that amount of the gas that is in equilibrium with a milligram of the metal. As the salts that are so often used are approximately 50 per cent strength, the confusion concerning the dosage would be lessened if all reporters would speak of it in the terms of the metal.

In 1915 there were 50 cases treated, the same number in 1916 and the remaining 20 have been under treatment this year. In the first part of the work there was no selection of the cases, but since the latter part of 1916 I have been quite particular in this regard. In the entire series there were three operable cases which were treated with radium alone, but in each of these cases there were physical or psychological reasons which made operation impossible. Following the treatment there were 3 cases operated on by others, each time with our concurrence or advice, and in all three the specimens were obtained. In 1915 and the early part of 1916, there were 26 patients who had the Percy operation previous to the application of the radium. A hysterectomy was done on one case of cancer of the body with extensive involvement of the uterine wall.

Technique. In 1907 Dominici devised the method of using hard radiations "the ultra penetrating rays" and cutting off the softer β-rays by filters of lead. His followers, Wickham and especially Cheron, led the way in the treatment of uterine cancer by this method. At first, amounts of 50 to 100 milligrams of the salt-RaBr. were used, but later Cheron arrived at the conclusion that the massive doses produce the best results, and warned against the use of the small dose of less than 50 milligrams.

At the Memorial Hospital, in 1915, one technique was continued throughout the year. It was patterned after the French method, and differed from it only in the time length of the applications. The applicators were similar to the ones so often shown — a small lead capsule about the diameter of a lead pencil and about 2.5 centimeters long, the wall being everywhere 2 millimeters thick; a flat, 2 millimeters thick, lead applicator 2.5 centimeters square for use in the vagina and a probe applicator of silver for use within the uterus. Besides the vaginal and uterine treatments applications were made within the rectum by placing the lead capsule within the T cross piece of a rubber tube similar to the ordinary vaginal drainage tube. After insertion into the rectum folded, the arms of the T would be lifted and serve to hold the applicator in the position desired. All of the applicators when used were covered with 2 millimeters of rubber except the silver intra-uterine probe, which was seldom so covered as it was thought at the time that the

uterine muscle would act as a sufficient filter for the secondary rays.

During the first nine months of 1915, many of the cases, about 30 in all, were given in addition to the radium, treatments with the Coolidge tube.

At the end of the first year the number of cases classed as in good condition amounted to 26 per cent, this figure changing to 10 per cent at the end of 1916. Still, the results of the first year were very unsatisfactory, for a great many cases had bladder or rectal irritation or both, and a very considerable number of them developed with the progress of the disease either bladder or rectal fistulæ.

Technique of 1916. Two changes were made in the technique at the beginning of the second year which still remain as standard:

First, the metal filter was changed from lead to platinum. The latter metal is a much better filter because of its density and the secondary rays are not as hard as those from lead, consequently, the irritation of the surrounding organs is not as great. The same change was made in many other clinics, but some covered the lead with brass or even used three metals to overcome this secondary ray effect.

Second, with the small capsule no application was made without having it inserted into the cervix or the uterus. In other words, the capsule was not placed in the vault of the vagina against the tumor, and whereas formerly the vagina was loosely packed with gauze in order to hold the radium in place, from this time on the gauze was applied with the purpose of giving distance between the applicator and the vaginal vault. The idea of obtaining distance led perforce to the giving up of the rectal applications.

These precautions made a striking difference in the comfort of the patients, for the proctitis and the cystitis cases became fewer in number and the total of those developing fistulæ in the course of their disease dropped to 6 per cent for the year, notwithstanding that the total average dose for each patient was much larger.

A trial was made of steel needles containing emanation for insertion into those tumors that grew out into the vagina, but burns from the β-rays observed in one or two cases led to a discontinuance of this method.

Development of the mercury filter apparatus now in use. Early in the second year, having desisted in the treatment of cross-firing from the rectum and vagina, I was forced to find a new method of filtering the radium so that it might again be undertaken. The repeated treatments week after week, with the radium applicator about in the same place in the cervix, resulted in a local necrosis of that portion which, after the first treatment, was presumably free of active cancer-cells. Knowing that the diffusion into the tumor of a lethal dose was not enhanced to any great extent by reapplication, and following the suggestion of Kelly and Burnam in their use of the larger doses surrounded by an extra filter in the shape of their lead cup, I constructed a solid lead globe with a diameter of 3.5 centimeters. One pole was sawed off and a set-in made to hold the platinum capsules. This was applied, with the capsules holding 1000 millicuries of the emanation, nine times during the months of March, April, and May, 1916. There were no burns, but there was considerable irritation of the neighboring parts. As the ionization through 2 centimeters of lead is less than 5 per cent of the original amount it would seem that possibly the irritative action was due to secondary rays.

As a filter for the rays, mercury is the best of all the metals. For all substances the coefficient of absorption is in relation to the density. For the lighter substances, as aluminum and iron, the increase of the absorption through varying depths of the material is almost exponential; but with the heavier substances, as lead and mercury, this is not so. With these latter materials, every millimeter of increase of thickness leads to decided changes in the absorption coefficient. The variation with mercury is much greater than with lead, and with penetration through a thickness of one centimeter or over the absorption is about one-third greater than with lead.

With these facts at hand, an applicator was then devised of about the same shape as the other but consisting of a thin cup or capsule of iron. Into this was poured mercury to a

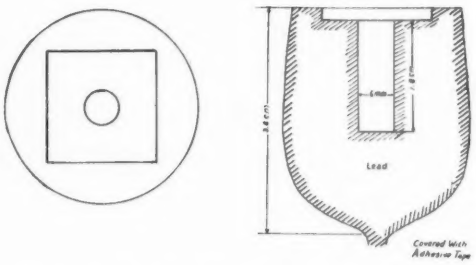


Fig. 1. At left, top view; at right section. First lead applicator

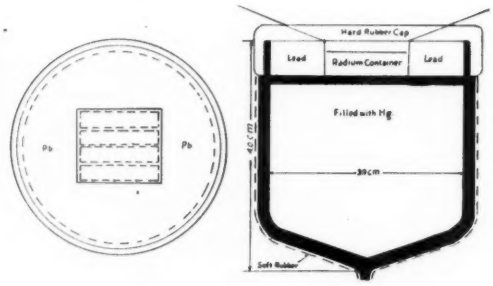


Fig. 2. Present container. At left, top view, at right section.

thickness of 2 centimeters. The top of this apparatus was a receptacle with its sides protected by 6 millimeters of lead to hold the platinum tubes, and over this was a hard rubber cap. Rubber tubing to the thickness of 2 or 3 millimeters was used to cover the iron. At the lower end was a flexible wire for directing the apparatus as in the Kelly and Burnam cup. Lately, another similar apparatus has been made with the side wall of the iron capsule extending 1 centimeter above the radium. The thickness of the mercury at the projecting end is one centimeter and behind the radium there are 2 centimeters. The Physical Department has roughly measured the ionization of bare radium through 1 centimeter of mercury and found it to be in the neighborhood of 1 per cent and through 2 centimeters to be 0.5 per cent. I hope later, with the help of Mr. Failla and his staff, to make accurate measurements of the ionization through varying thicknesses of mercury and as nearly as possible under the same conditions as would be met in the clinical work, so that if possible a smaller but equally effective machine may be constructed.

In using the "mercury bomb" two objects are to be accomplished: first, to cross-fire with a piece of radium within the cervix, and second, to carry the radiation for a considerable distance into the pelvis. Therefore, a platinum tube of 100 millicuries of the emanation is placed within the cervical opening and left for six hours. At the same time the apparatus is inserted into the vagina and directed toward the lesion in the cervix, and with the hard rubber cap pressed against the ulceration. It is kept in position for two hours by packing a strip of gauze between it and the vaginal wall, if the vagina is roomy, and by fastening the wire stem to the thigh by adhesive plaster. It is necessary to have the patient on the examining table throughout the treatment, so that the apparatus will not sag and lose its proper direction. The comfort of the patient is aided by placing a sandbag beneath the knees.

At the next vaginal application, usually the following week, the "bomb" is directed toward the right parametrium for one hour and held in place by strapping the stem with adhesive to the abducted and slightly flexed thigh of the opposite side. The left parametrium is then treated in a similar manner for one hour. The weight of the apparatus, about 12 ounces, permits of its use for only two-hour periods.

By this method a lethal dose for the average uterine cancer-cells is delivered into the pelvis for a distance of several centimeters. If, as histological examinations seem to prove, an amount of radium equal to 100 millicuries produces a lethal influence on tumor-cells at a distance of 3 centimeters, then as the strength of the radiation is inversely proportional to the square of the distance, 600 millicuries would deliver a similar dose to the cells at a distance of 7.3 centimeters according to the following formula:

$$\frac{\text{Distance}}{d_2} = \frac{1}{\sqrt{\frac{I_2}{\text{Intensity}}}} \quad \frac{3\,(\text{cm})}{d_2} = \frac{1}{\sqrt{\frac{600\,(\text{mc})}{100}}} \quad d_2 = 3\sqrt{6} = 7.35$$

In addition to the vaginal treatments, the lower part of the abdomen is divided into

TABLE I.—RADIUM DOSAGE

	1915	1916	1917 (4 mo.)
No. of cases	50	50	20
No. of treatments	172	140	45 abdominal 57 vaginal uterine
Average uterine or vaginal dose.	50 millicurie hours x 20 hours 1072 millicurie hours	100 millicurie hours x 15–20 hours 1791 millicurie hours	600 millicurie hours x 1 hour to 2 hours or 100 for 6 to 10 hours About 830 millicurie hours
Average total dose	3682 millicurie hours	5016 millicurie hours	2421 millicurie hours
Average abdominal dose	X-ray of 30 patients average dose 30 x	0	At 4 cm. distance 2934 millicurie hours
Average total dose	Average X-ray total dose 300 x	0	6577 millicurie hours

three segments, one over the symphysis and one at either side just above Poupart's ligament. Applications are made to these areas with the same mass of emanation as is used in the vagina. Instead of the usual radium pack of many small doses spread over a considerable area at 2 centimeters distance, the radium is placed in one mass at 4 centimeters and is left in place for six hours. It was found convenient to use a block of wood 4 centimeters thick to place the radium on, and the sides and cover of this block were lined with 3 millimeters of lead. This dose so used is just on the border-line of the erythema dose as I have demonstrated to my satisfaction. The rays at the distance of 4 centimeters are more homogenous, and thus the skin dose approximates that received deep in the pelvis. These abdominal treatments may be given the same 24 hour period as the first vaginal. In cases in which there is induration in the back of the pelvis, the same mass is also applied over the sacrum.

An example of recording an actual case under treatment is shown in table below.

Abdominal Treatments	Right 3000 mc. hr.	Center 3000 mc. hr.	Left 3000 mc. hr.
No. 24108 Vaginal treatments	625 mc.hours Bomb applicator.	1200 Bomb 540 capsule in cervix. 400 in cervix.	600 Bomb.
Sacral treatments	None	3000 mc. hours	

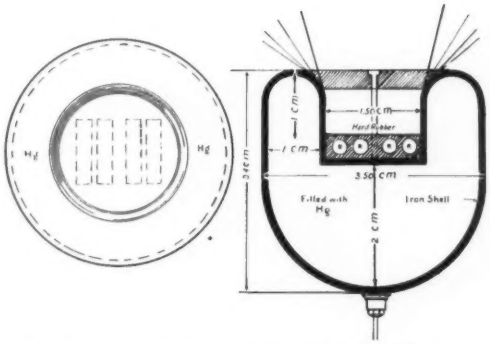
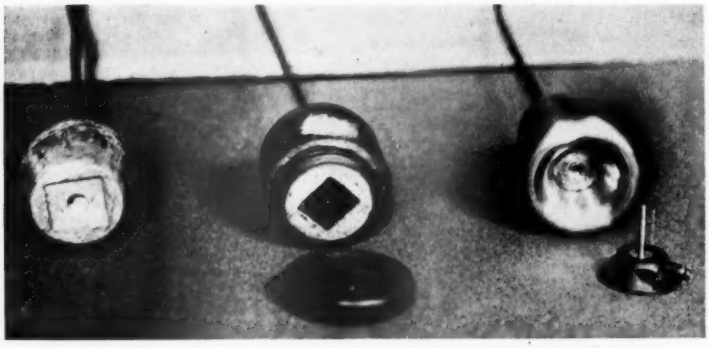


Fig. 3. Container under construction. At left, top view; at right, section.

In 21 women there have been 60 applications of the mercury apparatus between December 1916 and May of this year. In these women there have been only three cases of rectal irritation, and one of these patients is apparently free from cancer, and another is greatly improved. It is a little early to pass judgment as regards the irritation but the local slough so commonly seen in the old method seemed to be avoided.

In examining Table I it will be seen that the average dose of 1915 was small, and it will be remembered that the filtering was almost entirely of lead. During the second year the actual amount of the emanation used at each treatment was doubled and the time of application kept nearly as long. As far as we have gone this year the principle of cross-raying has been uppermost in our minds. While the radium amount has been many times larger, the time has been very much shortened so that as far as the various methods may be compared, the average total dose from the standpoint of millicurie-hours has been greatly reduced.

The abdominal treatments are accessory applications which may be compared with the roentgen-ray treatments of 1915. No one can read the history of Bumm's cases which were treated with X-ray alone, without drawing the conclusion that there is a future for this treatment of uterine cancer. The combined treatments with X-ray and radium is logical and the adopted technique in many clinics. The Γ-rays from a Coolidge tube per unit of



A. *B.* *C.*

Fig. 4. *A*, Old lead bomb applicator; *B*, present mercury filter; *C*, new mercury apparatus.*

time are far greater than any amount of radium that is apt to be used.

X-ray treatments which were given to about 30 cases were administered once a week. They were time consuming, and as the cases multiplied it seemed impossible to continue them. Furthermore, from the standpoint of frequency the treatments lacked force.

TABLE II. — RESULTS AS REGARDS PREVIOUS TREATMENT

		Number of Cases Treated	Unimproved		Improved	
			Dead	Unimproved	Greatly Improved	Apparently Free from Cancer
Primary	1915	17	15	0	0	2
	1916	31	17	6	3	5
Recurrent	1915	18	16	0	1	1
	1916	8	5	1	1	1
Percy	1915	15	12	0	1	2
	1916	11	9	0	0	2
		100	74	7 (81%)	6+	13 (19%)

In the classification of cases those which had an exploratory laparotomy or a simple cauterization were termed primary together with those that had no operative treatment. The recurrent cases were those that had some type of hysterectomy, and all but one were referred from other institutions. Of the Percy cases three were operated on elsewhere and the remainder were operated on by Dr. Mallett to whose service I am attached.

The recurrent cases show the lowest percentage of improvement and they were also the hardest to treat. The recurrence is usually behind the vaginal vault, and the vagina itself is usually foreshortened and contracted. The Percy and the primary cases show about the same percentage of improvement but the frequency of fistulæ in the former both immediately following the operation and after the radium treatments, have caused us to forsake the Percy operation as a procedure preparatory to the use of radium except in one type of case; namely, the cervical cancer with cauliflower-like growth extending into the vagina. It seems to me the large mass of this cancer may with profit be removed by the cautery and it is questionable whether the local use of the old-fashioned hot iron is not better than the more lengthy and formidable procedure. Nevertheless, the figures must receive consideration, and I may add that the four Percy cases now apparently free from cancer are in excellent condition.

TABLE III. — RESULTS AS REGARDS TIME

Time Since Beginning of Treatment	No. of Cases	Unimproved			Improved		Per Cent
		Dead	Unimproved	Per Cent	Improved	Apparently Free	
2 yrs.	12	10	0	0.833	1	1	0.166
1½ to 2 yrs.	36	31	0	0.861	1	4	1.139
1 to 1½ yrs.	17	15	2	1.00	0	0	0
6 mo. to 1 yr.	33	16	7	0.697	2	8	0.303
1 to 6 mo.	22	1	3	0.181	15	3	0.818

The primary cases are more amenable to the application of radium and the results are

* The term "bomb" is sometimes used in describing these applicators because of their resemblance to small hand grenades.

slightly better than where previous treatment had been instituted. Twenty-one per cent of this class showed marked improvement with the possibility of remaining free from cancer.

When a period of two years passes, a fairly good estimate may be made as to ultimate results; it would seem that not over 15 per cent of my cases lived to that period, but in these the probabilities of a complete retrogression are great. On the other hand over 80 per cent lived through the first 6 months, and it is very difficult to sift the good from the bad for nearly all show local improvement.

It is not easy to formulate any conclusions as regards the actual treatments, but I am convinced that the inoperable cases do better without the Percy operation. I believe that the initial dose of radium should be high and that it should seldom be repeated for the same area. Cross-firing should be made use of from within and from the surface of the body. The filters on the sides and back of the applicators used in the vagina should be so effective that no harmful effect can result to the surrounding tissues; and as mercury reduces the ionization more than any other metal its use for this purpose is advisable. Finally, the treatment should be completed as soon as possible, so that the time of a second application will not coincide with the irritative effects of the first.

I am indebted to Dr. William S. Stone, a director of the hospital, for his friendly consideration of my work and for his control of the findings as presented in this paper.

AN EXPERIMENTAL AND CLINICAL STUDY OF KIDNEY AND URETERAL STONES WITH A CYSTOSCOPIC METHOD FOR THEIR REMOVAL[1]

By VICTOR D. LESPINASSE, M.D., F.A.C.S., Chicago
Assistant Professor of Genito-Urinary Surgery, Northwestern University Medical School

TO discuss intelligently the problem of removal of ureteral stones, we must study closely the mechanics of the passage of stones through the ureter, without the aid of surgical art.

Ureteral stones are rarely formed in the ureter, being usually formed in the pelvis of the kidney, whereupon, engaging in the physiologically dilated kidney end of the ureter, and being arrested there, they are propelled downward into the ureteral lumen by two forces; namely, the normal ureteral peristalsis and the pressure of the urine, the greater force being the ureteral peristalsis.

The pathological stone as it passes, wedges its way through the ureter, causing a dilatation of that tube. This dilatation is at first the size of the stone; but the widening of the lumen of the section of the ureter above the pathological stone gradually becomes much greater than the diameter of the stone, because of the back pressure of the urine. This dilatation also involves the kidney pelvis, and calyces, and is rapid or slow depending upon the degree of obstruction to urinary flow occasioned by the stone, and also measured by the length of time the stone remains in the ureter. This dilatation produced by the back pressure of the urine becomes painful only when the stone completely obturates the ureter.

That section of the ureter between the pathological stone and the bladder is normal and undilated, and being of a lesser diameter resists the passage of the stone. Here then lies our problem: to expand this segment of the ureter painlessly and sufficiently so that the stone can pass into the bladder. My method accomplishes a painless dilatation of the ureter, the dilatation is perfectly controlled, and the stones must descend, after which the ureter gradually returns to normal size.

The pain caused by a stone passing through the ureter is due to three principal factors: (1) the irregular peristalsis of the ureter;

[1] From the Laboratory of Experimental Surgery (Genito-Urinary) of Northwestern University Medical School.

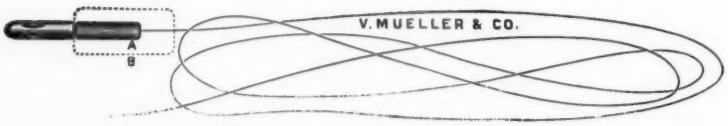


Fig. 1. Introducer and perforated artificial stone; dry *A*, wet *B*.

(2) local cutting, due to the roughness of many of these stones; and (3) the pain due to the sudden stretching of the kidney pelvis when a stone completely obturates the ureter.

I have devised an apparatus and method of using it, which reproduces the mechanism by which the ureter becomes painlessly dilated between the pathological stone and the kidney. This method permits these same dilating forces to act upon the segment of the ureter between the pathological stone and the bladder. By using this apparatus and method the ureter dilates without pain or discomfort. The ureter is not a straight tube of equal diameter throughout, but has several points of physiological narrowness, the smallest and least dilatable of these points being the ureterovesical orifice. My artificial perforated stone or cork is preferably made expansile, and when the artificial stone is placed in the ureterovesical orifice, this orifice will be dilated by the expansion of the artificial stone; consequently, when the pathological stone will have reached this point in its descent, there will be nothing to prevent the pathological stone from dropping out of the ureter into the bladder.

Perforated artificial stone or perforated cork, is the name I have chosen for my apparatus

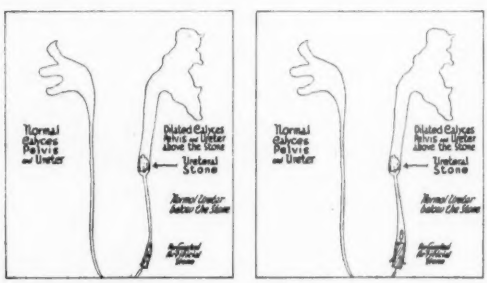

Normal Calyces Pelvis and Ureter
Dilated Calyces Pelvis and Ureter Above the Stone
Ureteral Stone
Normal Ureter Below the Stone
Perforated Artificial Stone
Normal Calyces Pelvis and Ureter
Dilated Calyces Pelvis and Ureter Above the Stone
Ureteral Stone
Normal Ureter Below the Stone
Perforated Artificial Stone

Fig. 2. *A*, (at left) dilatation of ureter between stone and kidney with perforated artificial stone in place at the vesico-ureteral orifice. *B*, Dilatation caused by the perforated artificial stone which has been in place a short time.

for ureteral dilatation. This instrument is composed of three parts: the introducer, the perforated artificial stone or cork; and the stabilizer.

The introducer is of two types. The first is composed of a metal cylinder 2 to 3 millimeters in diameter, closed at one end, with a fine, non-corrosive wire extending through the cylinder and attaching at the center of the closed end of the cylinder, two opposite holes being cut in the cylinder near this end to allow the urine to enter. The wire is about 25 centimeters in length, that is, long enough to extend through the cystoscope and allow of easy manipulation.

The second type of introducer is a small metallic ellipse, 2 millimeters at its shorter diameter and 3 to 4 millimeters at its longer diameter. To this ellipse are attached two small wings, so constructed that they lie flat, as the instrument is being pushed forward. When the instrument is withdrawn, these small wings immediately spread out, and enable one to remove the artificial stone or cork when traction is made on the wire.

The perforated artificial stone or cork is made either of metal or laminaria, preferably the latter. The length is 1 to 2 centimeters long and of diameters when dry from Nos. 5 to 9 French scale.

To allow of the free passage of the wire of the introducer, and later of urine, a small circular hole is bored through the center of the cylinder of laminaria or so-called artificial stone or cork, and this opening is spoken of as the "perforation." In describing our artificial stone or cork, you will note that we lay stress upon the word *perforated*, because non-perforation or complete obturation is not only very painful but is very dangerously destructive in its effect on the kidney, as the dilatation then is equal in every part of the urinary tract above the obstruction, while with the perforated artificial stone the

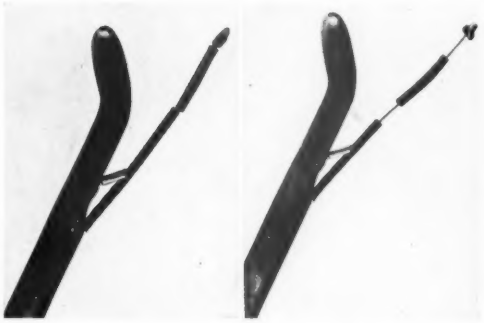


Fig. 3. (at left). Author's perforated artificial stone apparatus completely assembled appearing exactly as it should be to pass it into the ureter.

Fig. 4. The perforated stone apparatus is shown projecting from the operating cystoscope. Note the winged introducer, the perforated artificial stone and the stabilizer.

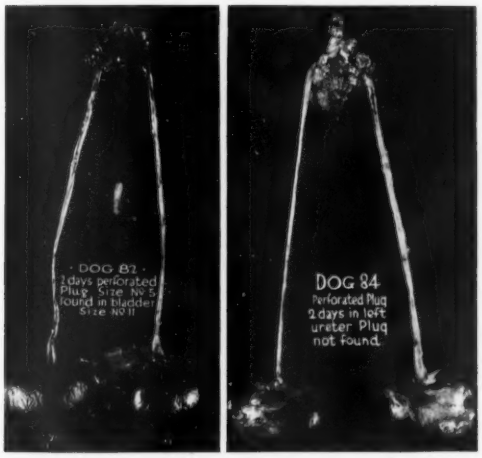


Fig. 5. Dog 82. Perforated artificial stone placed in the vesical orifice of the ureter; dog killed two days after perforated artificial stone was inserted. Perforated artificial stone found free in the bladder; consequently the effect shown was produced upon the ureter in less than two days. Note the equality in size of the two kidneys; note also the enlargement of the left ureter. The small object in the center is the artificial perforated stone that was used.

Fig. 6. Dog 84. Note the enormous dilatation of the ureter and the normal size of the kidney.

dilatation commences immediately above the perforated artificial stone and gradually extends up the ureter and only involving the kidney when allowed to remain for a relatively long time. When this laminaria or artificial perforated stone becomes wet, the diameter of the perforation increases in direct ratio as the over-all diameter of the artificial stone or cork. The artificial stones made of laminaria when wet will expand as follows: Nos. 5 to Nos. 11 and 12 and No. 9 to about No. 25 French scale.

The stabilizer is a ureteral catheter with the eye end cut off. The apparatus is assembled by passing the wire of the introducer through the perforation in the artificial stone, then further passing the wire through the stabilizer, so adjusting the parts that the cylinder of the introducer shall be in contact with one end of the perforated artificial stone and the stabilizer with the other end of the artificial stone. The stabilizer is held in place by a set screw on the wire of the introducer.

The apparatus when assembled forms one continuous slender instrument.

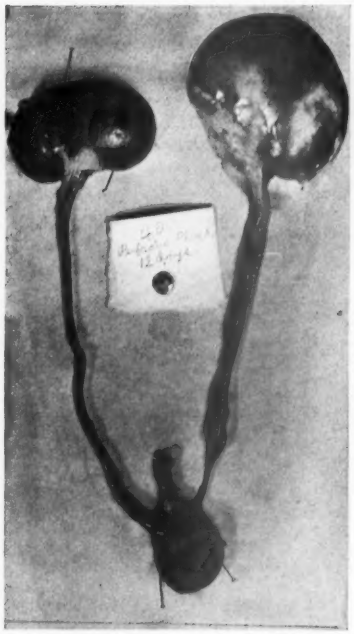
Sterilization. The introducer may be boiled; the perforated artificial stones or corks may be sterilized by soaking them in formalin solution. The formalin is removed by washing in sterile water. The perforated artificial stones should be dried under sterile conditions, and when thoroughly dried in this way, they are ready for use. The stabilizer is sterilized the same as any ureteral catheter.

Presuming that a pathological stone may have wedged its way a given distance through the ureter, the following procedure will be noted:

When the perforated artificial stone has been placed in the vesicle end of the ureter, the dilatation of the ureter begins immediately just above the perforated artificial stone or cork; and the dilatation gradually extends further and further upward toward the pathological stone.

When this widening process has reached the pathological stone and the lumen of the ureter is of sufficient diameter to loosen the pathological stone, this stone will descend to the artificial stone, whereupon the artificial stone is withdrawn and soon the pathological stone will drop into the bladder (Fig. 2).

Injuries to the kidney. The presence of a stone in the kidney or ureter indicates injury to these structures, the extent of this injury



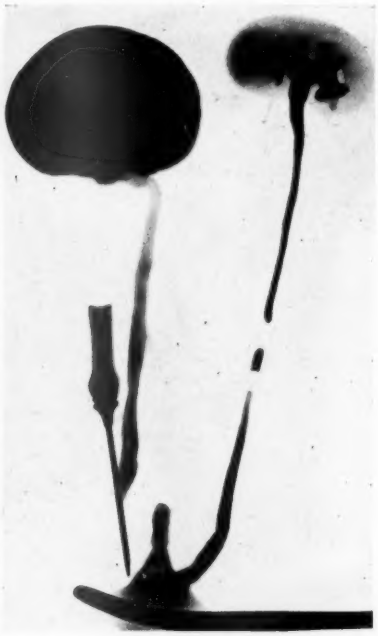


Fig. 7 (at left). Dog 40. Perforated artificial stones were placed in both ureters and allowed to remain for 12 days. The one to the right was placed in the ureter about one inch above the bladder so that this short segment of ureter would retain its normal size and thus serve to show by contrast the extent of dilatation produced by the perforated artificial stone in the opposite ureter. This perforated artificial stone became obstructed and the kidney became hydronephrotic. The ureter upon the other side dilated enormously, and the kidney itself did not.

Fig. 8. Pyelogram of Dog 40. The needle obturates the normal segment of the ureter and shows its exact size. Note the extreme dilatation of the opposite ureter and particularly the non-obliteration and non-broadening of the calyces. Too much pressure was used in injecting this specimen and some of the bismuth entered the kidney substance. This specimen illustrates beautifully the dilatation of the ureter and the non-dilatation of the kidney pelvis.

depending upon the size, character, and shape of the stone, and the length of time the stone has been in the kidney or ureter.

My method of treatment can, in no way, increase the injury to the kidney because this principle of dilating the walls of the ureter can be fully controlled and need not extend to the kidney, but by proper application and control of the perforated artificial stone or cork, this dilatation need extend only so far as one may wish to dilate the ureteral walls; in fact, ordinarily, the dilating forces would act only between the artificial stone and the pathological stone; or if the pathological stone may not yet have entered the ureter, but is still free in the kidney pelvis, a dilatation of the ureter and also a dilatation of the kidney pelvis may be produced which will allow the stone to engage in and pass down the ureter much more readily. The distance from the bladder affected by the forces of dilatation is entirely at the will of the operator; he may increase the dilatation at his discretion by regulating the time that the artificial perforated stone or cork is left in place at the ureterovesical orifice.

Injuries to the ureter. The dilatation of the ureter produced by the perforated *artificial* stone or cork will disappear after the apparatus is removed from the ureter. The local effect upon the walls of the ureter is slight, readily healing upon removal of the apparatus.

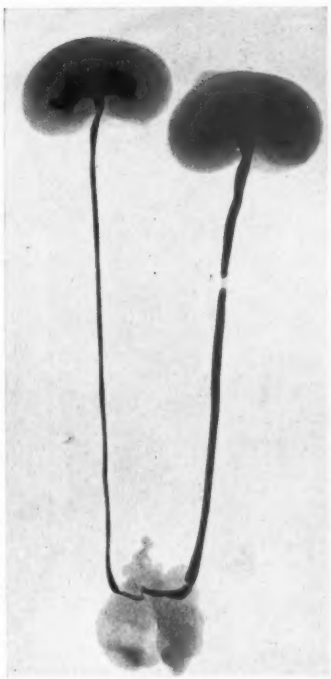


Fig. 9.

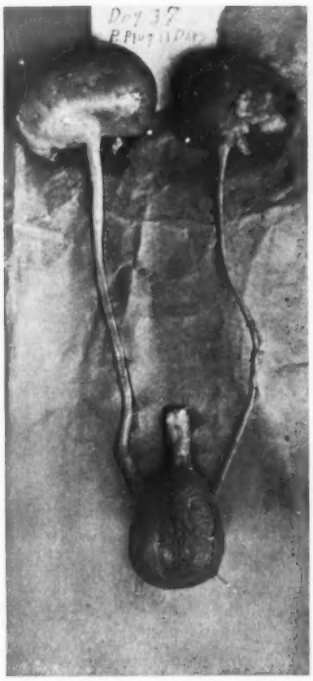


Fig. 10.

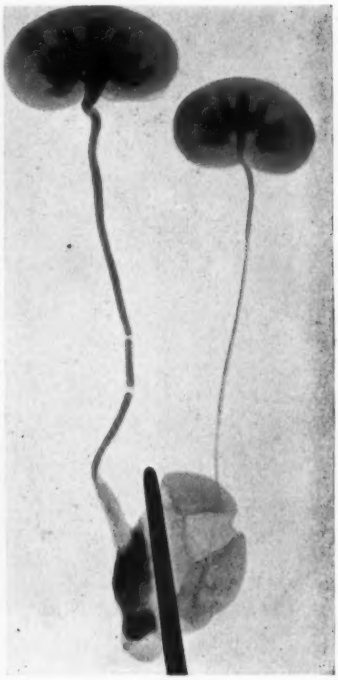


Fig. 11.

Fig. 9. Pyelogram, Dog 84. Perforated artificial stone in the ureter two days. Note the extreme dilatation of the ureter and the very slight dilatation of the kidney pelvis. Note that the calyces are slightly enlarged but not flattened. From this pyelo-ureterogram, one can see how small stones in the kidney pelvis would be more likely to engage in the ureter thus dilated and pass down into the bladder than if the ureter had not been dilated.

Fig. 10. Dog 37. Perforated artificial stone in left ureter for 11 days; slight infection. Note the enormous dilatation of the ureter and the slight enlargement of the kidney.

Fig. 11. Pyelo-ureterogram of Dog 37. Note the enormous increase in size of the treated ureter, also the increase in size of the kidney pelvis; note the broadening of the calyces; that while the calyces are broadened they are not flattened. A small stone in the pelvis of this kidney would simply roll down the ureter into the bladder.

Indications and contra-indications. This method is suitable for removing almost all types of ureteral stones and for small free stones in the kidney pelvis.

It is contra-indicated for larger kidney stones and very large ureteral stones having a diameter of more than one and one-half centimeters.

It is also contra-indicated in the presence of severe infection, or in case there is a very large amount of pus in the urine.

It is contra-indicated when the stone completely obturates the ureter, as in such case we will have no urine to produce a dilatation between the pathological stone and the perforated artificial stone or cork.

TECHNIQUE

Before this method of treatment is adopted, a comprehensive diagnosis should be made. We should first prove that stones do exist and that they are in the kidney pelvis or ureter, using the X-rays, the pyelogram, shadow catheter, wax tip catheter and ureterogram to aid in making this diagnosis. We should know the number, size, and location of the stone or stones either in kidney or ureter, we should ascertain whether or not urine is spurting from the ureter, by observing the ureteral ejaculation, or by use of the ureteral catheter. The presence or absence of infection should be known; if present, then the amount, character and virulence of such

Fig. 12.

Fig. 13.

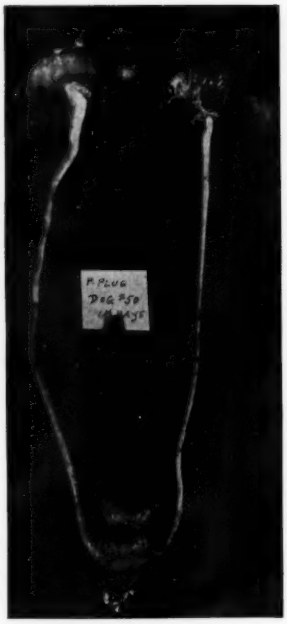


Fig. 14.

Fig. 12. Dog 51. Perforated artificial stone in right ureter for 14 days. Note the dilatation of the right ureter and the non-enlargement of the right kidney.

Fig. 13. Pyelo-ureterogram of Dog 51. Note the enormous dilatation of the ureter, the dilatation of the renal pelvis and the non-dilatation or flattening of the calyces. Consider how easily a small stone in this kidney pelvis could enter the ureter and pass into the bladder. The perforated artificial stone in this instance was passed out of the bladder and up the ureter about one centimeter. Note the short segment of the normal ureter connecting the mass of injection in the bladder with the dilated ureter. Compare its diameter with that of dilated ureter above it.

Fig. 14. Dog 50. Perforated artificial stone in ureter 14 days. Note the dilatation of the ureter, and the normal size of the kidney. Injected with bismuth paste.

infection should be determined by appropriate methods.

If possible, the functional value of the kidney should be determined, and the degree of dilatation of the kidney pelvis and ureter above the pathological stone should be visualized by a pyelo-ureterogram.

Fig. 15. Pyelo-ureterogram of Dog 50. Note the dilatation of the ureter and the broadening of the calyces. Observe how much more easily a stone in this dilated pelvis could engage in the ureter than in the normal one.

To determine the size of the pathological stone, we compare the shadow cast by it with the shadow cast by a No. 6 ureteral catheter or by using a segmented ureteral catheter, each segment of which is 1 centimeter in length. We may also determine the size of the stone by making a ureterogram and comparing this shadow with the one cast by the pathological stone.

When assured that there is stone in the ureter or kidney, the operating cystoscope is passed and urine observed coming from the ureter. The artificial perforated stone or cork is now passed into the ureter, leaving a small portion of the stone projecting into the bladder. Under no circumstances, should the apparatus be so placed that the perforated artificial stone or cork is entirely out of the bladder, one end of the artificial stone should

be left projecting into the bladder always. After holding the apparatus in place for a few moments, and when it is observed that the *artificial perforated stone* is thoroughly wet and has become somewhat enlarged, one should withdraw the stabilizer a millimeter or two, noting the actual distance of withdrawal through the cystoscope. The introducer is now pushed into the ureter a distance equal to the withdrawal of the stabilizer. The stabilizer can now be removed entirely or withdrawn a half centimeter farther. The cystoscope is now removed and the apparatus remains in place in the ureter with the wire of the introducer projecting from the urethra. It is a better plan to keep the cystoscope in place until we determine that urine is or is not passing through the perforation of the perforated artificial stone. If urine is passing, then we know that conditions are satisfactory for our purpose; if no urine is observed, and the apparatus is properly in place in the ureter, then the patient should be watched closely for development of pain, because if anything occurs to obturate the perforation in the artificial perforated stone, this fact will manifest itself by pain and the apparatus should be removed at once. Later, another artificial perforated stone should be inserted if necessary. If any complications develop, the artificial stone should be promptly removed and another inserted later as deemed necessary.

While the apparatus is in place, X-rays should be taken from time to time to determine the progress of the stone through the lumen of the ureter. When the shadow of the stone is in contact with the shadow of the introducer, the apparatus should be removed, permitting the stone to drop into the bladder. However, until the dilatation has extended sufficiently far to reach the pathological stone and loosen it, though that process should require several days, the apparatus may be left in place, carefully watching the dilatation, so as to remove the apparatus when the pathological stone has descended.

The greater the distance between the pathological stone and the bladder, the longer time it will be necessary for the perforated artificial stone to remain in place. For small stones, free in the kidney pelvis, it is feasible to dilate the ureter and also slightly dilate the kidney pelvis by this method, after which the patient should be thoroughly shaken on an orthopedic machine or the patient should ride over rough roads, hoping thus to engage these small stones in the dilated ureter.

DANGERS OF PERMITTING STONES TO REMAIN IN EITHER KIDNEY OR URETER

A stone in the kidney pelvis or ureter must cause progressive injury to the important kidney parenchyma from the earliest formation of the stone to its removal. At the present time, knowing the magnitude of an external ureterotomy, physicians advise expectant treatment for these ureteral stones, hoping that sooner or later the stones will pass spontaneously. Patients carry such stones in the ureter for years, having repeated attacks of colic, each attack advancing the stone a few centimeters; but during all of this period of time, a gradual, painless dilatation of the kidney pelvis and destruction of the renal parenchyma is taking place; furthermore, these irritated and compromised tissues are exposed to the ever present danger of infection from organisms excreted by the kidney; and thus, the kidney is gradually but completely destroyed, due to the uncontrolled dilatation and infection, so that when the stone is passed there remains the irremediable damage to kidney and ureter.

With my method of ureteral dilatation available, I would strongly advise that all cases of stone in the ureter or kidney be given active treatment as soon as the diagnosis is made. The presence of stone indicates immediate treatment.

CONCLUSIONS

To one skilled in cystoscopy, this apparatus and method properly applied offers a simple means of dilating the ureter from the ureterovesical orifice to a given point, or throughout the entire length of the ureter, and of increasing the diameter of the ureteral lumen as desired, and all without risk to the patient.

This method should replace cutting operations for ureteral stones and small free kidney stones to a very large extent.

GUNSHOT INJURIES OF THE LUNGS

Report of 30 Cases

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Chief Surgeon, Reserve Lazarett No. IV Deutsch Eylau, Germany, Summer 1916

IN a general way, war surgery does not differ radically from that of peace times, for most patients are taken care of according to general surgical principles. Though the types of injuries are manifold and of a nature infrequently encountered under ordinary circumstances, they respond promptly to the usual measures and require no special skill. This is not true, however, when we consider gunshot wounds of special portions of the body, such as the head, thorax, or abdomen. So much has been learned since the beginning of the war about the treatment of these special conditions that it is necessary to be familiar with these advances in order to get the best results. The development of intrathoracic surgery during the last years of peace, supplemented by the knowledge gained in the military hospitals, have opened up a vast field for useful work that promises to save many lives. It is, therefore, important that surgeons who intend to go abroad to do War Surgery have certain principles in regard to treatment fixed in their mind. They must know what are the most common immediate causes of death and what may lead to severe and fatal complications. It is only by a thorough understanding of these that proper therapeutic measures can be instituted.

Injuries of the thorax and its contained organs, are among the most frequent in war. This is easily understood when one considers the large exposed surface and the fact that even in protected positions the upper part of the body is more exposed than the lower. Statistics regarding the proportion of lung shots to all other injuries are available from many different fields of war, they vary considerably, depending on whether troops are advancing or whether they are in stationary positions. Sauerbruch, on the German side, has reported one group of 22,145 wounded with 8,034 dead among whom there were 836 with injuries of the lungs. This does not include those who succumbed to their wounds on the battlefield, because it is extremely difficult to get correct reports of these. Only once during the war has he been able to examine the dead on the field in regard to their fatal injuries, and among 300 soldiers thus examined, he found 112 with lung shots, or about 30 per cent. Adding to these the fatal terminations in the dressing stations and hospitals he concludes that the total mortality due to gunshot wounds of the thorax is somewhat over 40 per cent.

These figures show that injuries of the thorax are not as harmless as has been generally believed. This is due chiefly to the preponderance of heavy artillery, with high explosive shells, which produce injuries that are extensive, lacerated, and prone to infection. Whatever good results are obtained, and they are far better than in former wars, are due to two factors, first, the use of the small caliber, smooth jacketed, rifle bullet which produces small clean cut wounds that usually heal under conservative treatment; and, second, to the advances that have been made in intrathoracic surgery during peace times. These modern methods of treatment, however, can be applied in a warfare only with rather fixed positions and under good aseptic conditions.

At this stage of the war it is not possible to give a complete résumé of all lung injuries, their course and final result, because no one is in a position to observe and treat a large number of cases continuously. Depending on whether one is stationed near the front or in a reserve hospital, one sees lung injuries in different stages of convalescence. The severely injured, with hæmorrhage and fever, are kept near the front until it is safe to transport them, while the more lightly wounded are sent back early so that they may reach the reserve hospitals within a week.

The symptoms presented by patients with gunshot wounds of the thorax vary considerably. Some feel only a light blow when struck, and remain in the upright position, are able to continue in the combat for a while, or even walk to the dressing station unaided. By far the greater number, however, present a distinct picture of distress. They feel the entrance of the bullet as a heavy blow and usually fall to the ground. A condition of shock of greater or less severity supervenes, which may last for hours. The face is pale, pulse small and rapid, there is marked dyspnœa and frequently a moderate cyanosis. Distressing cough, pain in the chest and back and possibly immediate expectoration of blood, point to an injury of the lungs. The pain is often referred to the upper abdomen or the shoulder.

Dyspnœa is the most constant symptom present. It may come on immediately and be so severe as absolutely to incapacitate the patient or it may not come on until after he reaches the dressing station. Its cause is found in the injury to the chest wall, splintering of ribs, giving rise to irritation of the pleura and causing pain, in the collection of blood in the pleural cavity, especially in those cases that have walked for long distances after being shot, or in the entrance of air and the inability of a part of the lung to functionate.

Next to dyspnœa, hæmoptysis is the most frequent symptom. The amount of blood varies a great deal and is not an indication of the severity of the internal injury. Some patients state that blood shot out of mouth and nose immediately they were struck; in others it does not make its appearance until several hours later. Due to their excitement, or the darkness of the night, patients often do not notice the blood at all and it is not observed until their reception into the hospital. Regarding the amount of blood, it does not seem to matter whether the bullet perforated near the apex or the base of the lung. In the mild cases the bloody expectoration usually disappears in 3 to 5 days; it may, however, continue for several weeks in gradually diminishing amounts, as in Case 22.

In those patients that have an opportunity to rest for several days immediately after injury, there is often no hæmoptysis at all, showing that an early transport over the rough roads near the front aggravates the condition.

Subcutaneous emphysema in the region of the wound is frequently observed for the first few days, but as it is usually limited and rapidly becomes absorbed, it does not require much attention. It may even be beneficial, in that it carries oxygen into the recesses of infected wounds. Two of the cases here reported showed this symptom, Nos. 18 and 23, but no treatment was required for it.

A condition found in a great many patients with bullet wounds of the lungs, is hæmothorax. Of course, in practically all cases in which the pleura or lung is injured, is there a little bloody collection in the pleura which rapidly becomes absorbed, but in a smaller number of patients, in ten of my series, is there a sufficiently large amount to produce symptoms. These symptoms consist in dyspnœa and pain due to compression of the lung, in a serous pleuritis due to the presence of the blood acting as a foreign body, or the blood becomes infected, causing a so-called traumatic empyema, or, more commonly, an infected hæmothorax. The condition may lead to a thickening of the pleura producing a contraction of the lung.

The type of projectile determines to a great degree the condition of the wound and the subsequent course. Small jacketed rifle bullets striking sagitally usually produce a narrow, smooth channel, which frequently closes immediately after the bullet has passed through. As a result, bleeding is small in amount and even a pneumothorax does not form if air is not forcibly pressed into the pleura as the result of coughing. The entrance and exit wounds are about the size of a pea and crust over in a few days. Rarely are pieces of clothing or other foreign bodies carried inward, thus diminishing the dangers of infection and empyema. Such patients can be transported a few days after the injury and may reach a reserve lazarett within a week. The following illustrate such light cases:

CASE 1. P. H., age 27, wounded May 26, 1916. A rifle bullet entered the right upper arm, passed through the biceps, entered the thorax in axilla and passed out over the twelfth rib, about two fingers breadth from the midline. The patient did not lose consciousness. He expectorated blood two days. He felt weak but was not very sick. Much blood was lost from the thoracic wounds. Two weeks later he was walking about with all wounds healed. No symptoms were present in the lungs. The patient has anæsthesia of the index and middle fingers and is unable to flex the distal joints of these two fingers.

CASE 2. H. H., age 39. wounded April 6, 1916. A rifle bullet entered the right chest anteriorly below the nipple and passed out in the right costovertebral angle one inch from the spine. He did not faint. He coughed for a few days. There was blood tinged expectoration the first day. Although the bullet probably passed through the liver there were no symptoms referable to that organ. Both wounds were firmly healed after three weeks.

CASE 3. W. C., age 27 years, wounded June 3, 1916. A rifle bullet entered the right chest just below the clavicle, about its middle, passed through the lung and out below the spinous process of the fourth dorsal vertebra, exactly in the midline. The entrance wound was the size of a pea; that of exit, the size of a nickel. He did not faint and had no fever. He spit blood for 4 days. There was a moderate cough. Percussion note over the right lower chest, was dull; respiratory sounds not heard. Three weeks later, both wounds healed. He still has pain in the right lower chest on deep respiration. Respiratory sounds are heard over both lungs.

In case the bullet does not pass all the way through but becomes lodged in the thoracic wall, the symptoms may be no more severe, as the following case shows.

CASE 4. F. W., age 29, wounded about 1 year before admission. He was lying on a railroad embankment when he was struck by fragments of a shell exploding about 4 feet away from him. Large holes were torn into both buttocks. He was unable to get up and thinks he was unconscious about 15 minutes. He was dressed under fire but remained in his position for 4 hours before he could be moved. During this time he was struck in the right chest, felt great pain, and had marked dyspnœa. He had a cough before he was wounded but immediately after it became much worse and he expectorated blood for 2 days. After many weeks the wounds in the buttocks healed and he returned to the Army. There were no symptoms referable to the lungs. About 5 months ago he noticed a small, tender swelling, in the left anterior chest, which gradually increased in size, and for which he sought relief. Examination showed a hard mass, apparently a rifle bullet, over the second and third ribs, three inches from the median line, point directed upward. This was verified by X-ray which showed a faint shadow in the lung, suggestive of the track of the bullet. However, he had no symptoms. The bullet was easily removed under local anæsthesia. It was lying in the subcutaneous tissue, surrounded by about 1 ounce of turbid, sterile fluid. In this case both lungs must have been perforated.

It frequently happens that the same bullet which perforates the lung produces a fracture of a rib, the clavicle, the scapula, or the humerus, and thereby prolongs the convalescence. This is illustrated by the next two cases.

CASE 5. D. K., age 33, wounded April 14, 1916. A rifle bullet entered above the right clavicle, passed downward and backward through the lung and made its exit through the infraspinous fossa, about 2 fingers below the scapular spine. He did not faint. He coughed and had bloody expectoration for 3 days. Two weeks later he was feeling fine, there were no lung symptoms, the entrance wound was healed, but the exit wound, about the size of a dime, was still secreting, probably due to a little bone fragment.

CASE 6. F. L., age 34, wounded April 28, 1916. A rifle bullet entered the right anterior chest between the third and fourth ribs, in the midclavicular line, passed through the lung and scapula and became lodged under the skin, about the middle of the infraspinous fossa. The patient was sitting in a shell hole when struck, did not fall over, and did not faint. For about a half hour and again, 3 hours later, he had bloody expectoration, but he has not had it since then. He had a cough which lasted about three weeks. He had dullness, and absence of respiratory sounds over right base, and moderate temperature for several weeks. The bullet was removed under local anæsthesia. This wound drained for a long time, but healed after six weeks. At that time there was still little pain on deep inspiration. Respiratory sounds were present. The general condition was good.

Wounds caused by artillery projectiles are usually quite different. Shrapnel balls may pass right through, leaving a clean, smooth wound, as do rifle bullets, but on account of their size they make larger openings. Due to their low speed they frequently lodge in the thoracic cavity and are more apt to carry in foreign bodies.

CASE 7. P. H., age 37, wounded June 13, 1916. A shrapnel ball passed from above on the left, downward and backward to the right. It undermined the skin of the lower jaw and neck about 3 inches, came out just above the larynx and then entered the right thorax immediately below the clavicle about its middle. It passed through the lung and made its exit in the lower part of axilla.

The patient did not faint until about one hour after the injury. The entire musculature of the right chest became tremendously swollen, evidently due to the severance of a vessel. There was no crepitation. He expectorated blood about 2 hours. He had a rather distressing cough, which lasted about two weeks. There were no positive signs in the lungs. Examination was difficult on account of swollen muscles. Two weeks later both wounds were almost healed. The chest wall was normal. There were no signs in the lungs. The temperature was normal throughout.

CASE 8. A. H., age 36, wounded April 11, 1916. While standing over a trench pumping out water a shell exploded immediately above him. A shrapnel ball entered the left lower thorax posteriorly, at the level of eighth dorsal vertebra, traveled upward and to the right through the right lung and lodged under the skin of the right axilla. He felt very hot when struck and says his legs gave way. He fell backward but had sufficient presence of mind to shout to his comrades in trench, "Lung shot." While lying on his back blood would shoot out of his mouth with each expiration. He did not lose consciousness. He was dragged into trench by his friends and reached a dressing station about four hours later. Here he was kept for a week, on his stretcher because he was losing so much blood. After some hours hæmoptysis lessened, and he would expectorate blood only when coughing. This continued for 8 to 9 days and then stopped, and has not returned. The bullet was removed under local anæsthesia. Two weeks after injury both wounds healed. There was no cough, no sign in the lungs. He was kept in bed on account of a large bedsore caused by pressure necrosis. During the early days when he bled so much he was not moved at all, was not even undressed, and as a result he was lying on his belt buckle which caused this necrosis.

Shell fragments, because of their irregular size and shape, produce large ragged wounds with considerable defect of tissue and often extensive injuries of ribs and chest wall. Many succumb as a result of the first shock, others recover after more or less stormy convalescences.

CASE 9. W. K., age 39, wounded April 11, 1916. A shell splinter entered above the right clavicle, passed through the lung and out through the lower part of the right scapula. He was not very sick. He coughed and expectorated blood for about 3 days. Three weeks later the wounds were clean, but were still secreting. No signs were present in the lungs. Patient walking about.

CASE 10. A. R., age 38, wounded February 16, 1916. A shell splinter entered the left chest to the inner side of the scapula, passed through the lung, made its exit in the lower axilla and then passed through the arm, shattering the humerus. Symptoms referable to the lungs were not severe. He expectorated blood 2 to 3 days, and then quickly recovered. The wounds healed in about 3 weeks. The comminuted compound fracture of the humerus, however, required prolonged treatment.

I report the following case to show that the late result of such perforating injuries of the lungs may be very good.

CASE 11. J. M., age 21, wounded about 7 months ago, October 4, 1915. A shell exploded at a distance of approximately 10 meters. He does not remember pain or anything as he lost consciousness immediately. He came to about 4 hours later in a dressing station, and immediately after that he was transported on a wagon to a field hospital. He had severe pain in the right chest, arm, and right leg. He had great difficulty in breathing, and for about 6 days severe cough and considerable expectoration of blood. He had fever for several days. The wounds healed slowly. He was admitted to our hospital for a fistula of the right leg, leading to a shell fragment 1X2 inches, embedded in the head of the tibia. At this time his thoracic wounds and arm were entirely healed. There were no signs in the lung and no symptoms referable to it. Shell fragment had entered just below the clavicle, passed through the apex of the lung and then out through the upper end of the humerus, shattering it. As a result of this he had a circumflex paralysis, atrophy of deltoid, and partial ankylosis of the shoulder. Function of elbow and hand are normal.

CASE 12. A. E., age 36, wounded April 28, 1916, during a storm attack on a Russian position. A shell fragment entered at the acromion process tearing an opening about 1 inch in diameter, passed through the lung and out to the right of the spinous process of the third dorsal vertebra. The exit wound was lacerated and about 2 inches long. The muscles of the right shoulder were much swollen and tender. The patient fell but did not faint. He was dressed on the field and remained there most of the day. Late that night he reached a field hospital. He expectorated a great deal of blood. Dullness and absent breathing developed at right base, reaching to scapula.

A second piece of shell struck the patient in the right forearm, lodging there and fracturing the radius. The wound secreted a great deal. The patient had a little fever all the time, which reached about 104° about a week later. The exit wound was enlarged to facilitate drainage. There was gradual improvement until June 8, almost six weeks after the injury, when the temperature again rose to 104°. There was pain and swelling along the entire bullet canal. This was, therefore, laid wide open from acromion to wound of exit, exposing the supraspinous fossa. Bone fragments and pus were evacuated. The hæmothorax which the patient had developed after his injury had become entirely absorbed by this time and there were no symptoms referable to lung. Uninterrupted convalescence after the operation.

In case a bullet or a shell fragment becomes lodged in the lung or mediastinum, but has not carried in foreign bodies, thereby preventing infection, the course does not differ materially from that of perforating injuries. I have seen a number of cases in which the bullet had become firmly embedded and who had slight or no symptoms referable to the lungs. Whether they will cause trouble later is problematical, but as by that time pleuritic adhesions will have formed, localizing the field, they can then be attacked more easily and with less danger to the patient.

CASE 13. E. N., age 31, wounded April 19, 1916. A rifle bullet entered the right chest below the second rib, about 1 inch from the sternum. He coughed moderately for 2 days. He had no hæmoptysis, no hæmothorax. Eleven days after the injury the wound healed. The only remaining symptom is occasional pain in the chest. There are no abnormal physical signs in the lungs.

CASE 14. J. H., age 27, wounded March 12, 1916. A rifle bullet entered below the left scapula. For 4 to 5 days after injury he coughed and expectorated blood. Since then, he has been well, except for some pain in the left anterior chest during deep inspiration. The wound healed in 3 weeks. The X-ray shows a bullet in the anterior part of lung, near the fourth rib. There is no temperature. On examination there are pleuritic friction râles over posterior and anterior surface of the lungs.

CASE 15. G. N., age 31, wounded June 8, 1916. A shell splinter entered the left chest posteriorly, just below and to the inner side of the scapula. The patient immediately complained of severe pain in the chest, and was unable to sit up. He coughed a great deal, and had profuse hæmoptysis for 11 days. During all this time there was temperature, which was highest on the fifth day, up to 103°. Twelve days after the injury the wound had healed and pain had become less, and in about three weeks the cough stopped. The only complaint he had at that time was pain over the anterior chest re ion, about the second and third rib, 3 inches from the median line. At this place the X-ray located a small shell fragment, probably adherent to the inner side of the chest wall. There were no symptoms externally, no œdema or tenderness. At the right base there is still dullness and diminished breathing. In view of the fact that symptoms are subsiding, it is to be assumed that the fragment will encapsulate.

CASE 16. H. W., age 19, wounded June 30, 1915. He was struck simultaneously by two shell fragments and a shrapnel ball. The shell burst at a distance of about 10 meters, while he was lying on an embankment; he slid down, but did not faint. He felt no pain, but had a sensation as if struck hard. Breathing immediately became very difficult. All wounds bled profusely. One shell fragment had entered above the right clavicle and lodged in the tissue; a smaller one entered through the right axilla and according to the X-ray lodged in the lungs. He coughed for a few days but did not spit blood. Both wounds healed promptly and when the patient was admitted to our hospital a year later, the X-ray showed both splinters well healed in place. There were no symptoms referable to the lung and no abnormal physical signs to be made out.

He came to us for a fistula of the right hip, the result of the shrapnel injury. He had been operated on unsuccessfully four times, but the bullet had not been found. The hip was ankylosed and there was a profuse discharge. After a diligent search I located the flattened shrapnel ball in the ramus of the ischium and removed it. The wounds healed in about four weeks.

The treatment of clean smooth wounds of the thorax and lungs is simple and strictly conservative. Patients should be put to bed at the earliest opportunity and kept with the upper part of the body elevated. One of the most important things is to give an early and sufficient dose of morphine, which should be repeated at regular intervals. It quiets the patient, removes his fear, facilitates breathing and expectoration. The wounds should be covered with sterile dry gauze and the dressing not changed unnecessarily. Early transport, especially over rough roads, is to be avoided, as it always aggravates the condition and frequently brings about a return of the bleeding. It will be seen from the cases here reported that a number of them were kept in a dug-out dressing station for several days because their condition did not warrant transporting them. Those that are not moribund usually reach the field hospital within 24 hours after their injury. Most of them present a very sick appearance at their reception, due to pain, dyspnœa and the distress of transport over the rough roads, often under the enemy's fire. As far as possible, they are here kept in separate barracks, where the chief requirement for a cure, absolute rest, can be obtained. All are carefully observed and complications guarded against.

Three factors that materially influence the prognosis and that require attention are (1) hæmorrhage, (2) the entrance of air into the pleural cavity, and (3) infection.

Hæmorrhage presenting outside, usually

comes from vessels of the chest wall, although the source may be in the intrathoracic organs. Bleeding from an intercostal artery or the internal mammary may lead to a fatal issue. If large in amount, therefore, the source should be looked for and if in the thoracic wall, the vessel ligated. If difficulty is experienced in controlling bleeding, a mass ligature or a Mickulicz tampon may have the desired effect.

Injuries of the large vessels passing through the thorax or of the vessels of the lungs may quickly terminate in death. Next to a double open pneumothorax, these hæmorrhages from large vessels are the most common cause of death in lung injuries on the battlefield. Hæmoptysis, although it may be severe, as in Cases 8 and 22, is practically never fatal.

Bleeding from the lung substance itself is rarely fatal, for the blood pressure of the pulmonary circulation is low, and after a certain amount of blood has collected in the pleural cavity, the lung is compressed and the vessels thereby obliterated.

Occasionally a secondary hæmorrhage occurs, usually in 8 to 14 days after the injury. Fortunately they are rare. They are due to disintegration of tissue or the erosion of a vessel in the bullet canal of the lungs. These hæmorrhages come on suddenly, and are often fatal; after an uneventful convalescence there is a sudden change in the patient's condition. He becomes pale, pulse small and rapid, temperature drops and dullness in the chest increases, and in a few hours death may ensue. One of my cases, 25, had a mild secondary hæmorrhage three weeks after injury.

Blood collecting in the pleural cavity is called hæmothorax. The amount of fluid varies considerably. At times it does not rise to the angle of the scapula and becomes absorbed in a comparatively short time. No treatment is required except, perhaps, a Priessnitz. Cases 3, 6, 12 and 15, belong to this class. More often, however, the blood rises above the angle of the scapula and may give indications for surgical interference. Early puncture should be avoided because it may lead to a secondary hæmorrhage and because it favors infection. It is indicated only if symptoms of compression of the lung become alarming. Usually one should not puncture before the tenth day, but then the removal of quantities of blood may be most beneficial. Patients with a hæmothorax usually run a temperature for 7 to 10 days, reaching its highest point about the fifth day, 102 to 104°, and then gradually subsiding. If the temperature keeps up one or two tappings will make it come down to normal. The following cases are typical of this condition:

CASE 17. H. S., age 32, wounded June 12, 1916. A rifle bullet passed through the right lower chest and probably the liver. Entrance between ninth and tenth rib in mid axillary line and exit between eleventh and twelfth rib, 3 fingers from the median line. He did not faint. He expectorated blood for four days and after that had blood-tinged mucus as long as the cough continued, about eight days in all. The highest temperature on the second day, was 103.6°. The patient had dullness and absent respiratory sounds to one finger above the angle of the scapula. He had tenderness in the liver region. There was no rigidity of abdomen; no vomiting. Two weeks after the injury both wounds were almost healed; temperature normal; dullness diminishing. Three weeks after the injury wounds healed. He has pain on deep inspiration of right lower chest. Respiratory sounds are heard over entire chest.

CASE 18. A. B., age 34, wounded May 2, 1916. A rifle bullet entered the right side between the eighth and ninth ribs in the midaxillary line, passed through both lungs, and emerged through the middle of the left scapula. He was dressed on the field and then transported to field hospital. When admitted there he looked very sick, had lost much blood on transport, his face was blue, pulse small and irregular, and respiration difficult. Around the entrance wound there was a hæmatoma the size of a hand and also subcutaneous emphysema. A saline infusion was given, also suprarenin and morphine hypodermatically. The following day a diagnosis of hæmothorax was made. This gradually increased in size with a steadily rising temperature, reaching 104° on the seventh day. As there were marked symptoms of compression of the lung with displacement of the heart, 800 cubic centimeters of a sanguinous fluid were aspirated. Marked improvement in general condition followed and the temperature dropped to 102°, and then gradually diminished. The patient had hæmoptysis for four days. Seven weeks after the injury both wounds were healed, there was little dullness left lower chest and pain on deep inspiration. He still coughs and has a yellowish expectoration, no odor, no temperature, general condition good, X-ray negative.

CASE 19. H. B., age 20, wounded May 16, 1916. A rifle bullet passed through the left lung. Entrance in front between the third and fourth ribs in the nipple line; exit close to spinous process of sixth dorsal vertebra. He did not faint. He was dressed on the field, and late at night reached the field hospital. At admission, entrance and exit wounds were the size of a pea, clean and not bleeding; pulse small, rapid; marked dyspnœa. Dry dressing was applied and morphine given. Hæmoptysis for four days. The first three days he had fever, 102.6°. May 27, 1916, the temperature rose to 103.8°, June 1, 1916, temperature has kept up; therefore aspiration of 200 cubic centimeters thin bloody fluid. June 5, 1916, temperature not changed; aspiration of 30 cubic centimeters fluid blood; no infection. June 10, 1916, aspiration of 500 cubic centimeters dark bloody fluid. June 17, 1916, since aspiration general condition much improved. Temperature has gone down to normal. June 28, 1916, the patient is feeling fine, has dullness and some râles at base of left lung; no fluid, no temperature; complains of some pain along intercostal nerves, probably due to injury of nerves by bullet.

CASE 20. O. W., age 30, wounded June 1, 1916. A shrapnel ball passed through the left upper arm, 5 fingers below the acromion process, perforated the humerus, and then entered the chest, becoming lodged under the skin close to the spinous process of the tenth dorsal vertebra. He fainted and was carried away in critical condition. He was kept in a dugout dressing station for a day and then transferred to a field hospital. The wounds were clean. There was considerable dyspnœa and cyanosis; profuse hæmoptysis; hæmothorax reaching to above angle of scapula. June 7, 1916, wounds clean. Highest temperature patient had was 101.8° on third day. At present temperature is normal. He still has little blood mixed in scanty mucopurulent expectoration. The bullet was removed under local anæsthesia. June 28, 1916, the wounds are healed. He has dullness at base of left lung, with numerous râles; no pain; temperature normal, cough slight. Function of arm and hand normal.

An uninfected hæmothorax, if left untreated, usually becomes absorbed and restitution to almost normal takes place in the course of weeks. In case, however, no tendency to absorption is shown, it is wiser to aspirate, because the condition may lead to a thickened pleura, contraction of the lung, retraction of the thorax, etc., none of which seriously endanger life, but which materially reduce the working capacity of the patient. It is best not to begin before the tenth day, and to take a small quantity of fluid at first, in order to prevent secondary bleeding. Removal of a small quantity often brings about considerable improvement and seems to stimulate the absorption of the remaining fluid. If necessary, two or three tappings may follow. Done under aseptic precautions there is no danger to this proceeding.

CASE 21. H. H., age 21, wounded April 26, 1916. A rifle bullet entered to the left of the trachea, one-half inch above the left sternoclavicular joint, passed through the neck and the right lung, and then out close to the outer border of the angle of the scapula. He fainted, and was at first treated in a dugout dressing station, and the next day transferred to a field hospital. He was very sick, and lost much blood through the nose and mouth. For two days he was unable to swallow. The voice was never affected. He expectorated blood about 14 days. The entrance wound was small, the exit wound the size of a half dollar. There was dullness in the chest reaching to the spine of the scapula. During the following days, there was gradual improvement; highest temperature 101.6.° Because there was no tendency to absorption of the hæmothorax, 200 cubic centimeters of dark red blood were aspirated eighteen days after the injury. During the next few weeks exploratory punctures were done repeatedly, always with a negative result. Convalescence was much prolonged. Two months after the injury, the general condition was good; the patient looked well and healthy, but he became short of breath easily. Dullness still reached to the angle of the scapula and over this area breath sounds were much diminished. A diagnosis of thickened pleura was made.

On account of the prolonged hæmoptysis (14 days) the first aspiration was not done until eighteen days after the injury. This may have been a mistake. It is possible that an earlier aspiration of a small quantity of blood, frequently repeated, if no untoward symptoms developed, might have prevented this thick pleura from forming. In case a puncture is negative it is well to remember to try in other places, because thick fibrin masses may interfere. For the same reason it is wise to use a large caliber needle.

CASE 22. A. M., age 36, wounded March 31, 1916, from a shot at a distance of about 70-80 meters. He was working, digging trenches, and just happened to be on top piling up earth. Russian trenches were only 25 meters away. He was stooping when struck, felt as if he were dealt a heavy blow. He fell backward, immediately jumped up, and then fell forward. He did not faint, called for help, but no one came to his assistance because the bullets were flying so thick. With each expiration blood shot out of his mouth and nose. He was unable to get up but crawled to the edge of a trench and was

drawn down by his comrades. Breathing was very difficult. During the first hour his chief complaint was pain in the abdomen; he says he cried with pain. After an hour he felt very faint and remembers hearing surgeon say that he would probably die. He was carried to a dugout dressing station where he regained consciousness. He stayed here 17 days because he was so sick that he could not be moved. He spat blood freely for 11 days, and then it gradually diminished. During this time he was given no food or drink, just hypodermoclysis. A rifle bullet had entered the left chest through the lower part of the scapula, passed through both lungs and then out through the right upper arm about the attachment of the deltoid. The wounds were clean and healed without any disturbance. When admitted to my service a month after the injury the patient was still very sick. He was anæmic, had marked dyspnœa and was running a temperature up to 102.6°. He coughed a great deal, and the expectoration was at times blood-tinged. There was a hæmothorax present on the right side reaching to three fingers above the angle of scapula. He was kept in bed, in an upright position, a Priessnitz applied, and inhalations and expectorants given. Gradual improvement set in. In the course of the next few weeks he was repeatedly aspirated, removing sometimes a larger, then again a smaller, amount of blood-tinged fluid. In spite of that the lung did not expand properly, dullness remained, there was bronchial breathing in parts over the lower lobe and continued dyspnœa. About three months after injury I discharged him from the Army and sent him to a farm for convalescence. Diagnosis at discharge: fibrosis and contraction of lung, and thickened pleura.

In this case it was not the thickened pleura alone that prolonged the convalescence and left the patient rather disabled. It was actual destruction of lung substance. We have to consider here that the man was shot at short range, 70 to 80 meters, and it is well known that rifle bullets fired at that distance have not only a penetrating, but also an explosive action. The prolonged hæmoptysis and the fact that he was so very sick after the injury, speak for this destruction. Had he been moved early the result might have been fatal.

Not all cases with a hæmothorax run this rather smooth course. It frequently happens that the blood in the pleural cavity becomes infected. This infection may set in at once and give rise to the so-called traumatic empyema, recognized by immediate high temperature, frequently with remissions, and possibly a chill. In such cases the infection is usually carried in from without. The prognosis is bad. Early rib resection with ample drainage, is the treatment. Most commonly the infection sets in gradually. The temperature, which at first is somewhat elevated, due to absorption, becomes normal for a number of days and then again rises. Such secondary rises must always awaken the suspicion of a secondary empyema, a so-called infected hæmothorax. One should not hesitate to do an exploratory puncture early. In case pus is found, aspiration alone may be sufficient, or a rib is resected in the usual way. At times an empyema opens spontaneously through either the wound of entrance or exit. The source of infection may be the channel of the bullet in the lung substance, or it may be carried in from without.

CASE 23. E. B., age 21, wounded May 13, 1916; admitted to field hospital same day. A shrapnel ball had entered the anterior left chest between the second and third ribs, and lodged there. He was admitted with severe dyspnœa and rapid pulse; no bleeding; no fever. The patient had considerable pain in the left chest, an extensive subcutaneous emphysema developed, and a pneumohæmothorax could be made out. Three days later pus exuded from the wound. The temperature had gradually risen and continued high, about 103.4° for the next few days, making a puncture advisable. Thirty cubic centimeters of dark blood was removed. The temperature subsided. Three weeks after the injury a portion of the eighth rib was removed under local anæsthesia, because the temperature had begun to rise again, and a large amount of bloody pus evacuated. A shrapnel ball was felt over outer surface of scapula and was removed under local anæsthesia. Two dressings and irrigations were administered daily, and resulted in considerable improvement.

Six weeks after the injury the general condition was good; there was still considerable pus discharge from the thorax. There was no cough. The prospect of cure is good.

CASE 24. H. F., age 21, wounded April 28, 1916. A shrapnel ball entered the left chest between the eighth and ninth ribs in the midaxillary line, and passed through the lung and out under the left scapula, fracturing a rib at exit. The patient did not faint. He expectorated blood for about 2 days. The next day a hæmothorax was present; temperature 103.6°. The temperature then gradually subsided until it was normal in a week, and remained that way a few days and then again went up, reaching 103° about three weeks after the injury. The suppurated hæmothorax ruptured spontaneously through the wound of exit. The latter was enlarged, several bone splinters removed and a drainage tube inserted. When the temperature did

not go down after this, additional punctures were made and a second pus cavity found. This was opened by rib resection, about five weeks after the original injury. Both cavities continued to secrete profusely, but the temperature went to normal and the patient's general condition improved very much. Two months after injury he was feeling fine, still discharging a great deal, however. The prognosis was good.

CASE 25. H. F., age 22, wounded May 5, 1916. A shrapnel ball entered at the right border of the sternum at the junction with the fifth cartilage, passed through the lung and came out between the seventh and eighth ribs in the mid-axillary line. He fell down, and was unable to get up. Immediately he became very sick; severe dyspnœa and cyanosis. With each respiration, dark frothy blood would exude from the entrance wound and air would escape. A firm, dry dressing was applied and morphine given. Elevation of upper body. He was kept at the dressing station until the next day, then sent to a field hospital, where a large pneumohæmothorax was diagnosed. Conservative treatment was continued. The open pneumothorax closed spontaneously on the second day. There was gradual improvement in the general condition but the temperature rose steadily from the day of injury. On account of this continued high fever and severe dyspnœa, 200 cubic centimeters of dark blood were aspirated 13 days after the injury. There was some improvement in breathing after this but the cough continued and dyspnœa again became severe coincident with a steady rise in fever. On May 30, hæmoptysis developed and the following day there was a rather severe hæmorrhage from his mouth. Dyspnœa became extreme. Therefore, in spite of the hæmoptysis an aspiration of the chest was done and 1500 cubic centimeters of blood, mixed with pus, was removed. Improvement was marked after this. Two days later 5 centimeters of the eighth rib were resected under local anæsthesia and thoracic drainage established. During all these days the condition of the patient was critical, saline infusions, stimulants and morphine were freely resorted to. After this operation the patient's condition steadily improved so that three weeks later the drainage had almost stopped, and the patient had no complaint to make. The prospect for cure was good.

It will be noted that these three infected cases were injured by shrapnel balls. As has been stated before, they are more liable to lead to infection than rifle bullets.

The condition of air entering and collecting in the pleural cavity is called pneumothorax. In most cases of perforating injury of the lungs, the amount is small, it enters either through the wound in the thoracic wall or the lung. Clinically, it is often difficult to make out and is of little importance. If the air in the pleural cavity does not communicate with the outside, the condition is called a closed pneumothorax. Should the amount of air be large and give rise to compression symptoms, relief is easily obtained by puncture and aspiration.

If, however, the hole torn in the chest wall is large, as the result of a shell fragment or a rifle bullet striking transversely, the tissues will not be able to close spontaneously. As a result air is passing in and out with each respiration. This is called an open pneumothorax. It is always to be considered a serious condition and requires active therapeutic measures. Double open pneumothorax is probably the most common cause of death in lung injuries on the battlefield. Many of those with a single pneumothorax and extensive destruction of the chest wall likewise succumb to the entrance of air plus the primary shock either on the field or at the first dressing station. All those that are brought in are extremely ill, and with their dyspnœa, cyanosis, and anxious expression present a distressing appearance. Here, again, morphine is of great importance to quiet the patient and make respiration easier. The primary indication for the moment is to do away with the principal danger, an open pneumothorax, and by some means convert it into a closed one. It does not seem to matter so much whether only the chest wall is open, or whether in addition to that, the lung is injured. The danger lies in the fact that air can enter and cause grave disturbances of respiration and circulation, and in the fact that infection of the pleural cavity is almost sure to take place. In case the opening is small, as in Case 25, the only thing necessary is to apply a firm bandage which will compress the tissues sufficiently to close the opening. This closure is aided by blood-clot or by a portion of the lung becoming adherent. If the opening is larger, but the wound clean, a primary suture may be done. Unfortunately, however, these injuries are usually caused by artillery projectiles which produce extensive lacerations with fractures of one or more ribs. Shell fragments or other foreign bodies may be

embedded in the chest wall or in the lung substance. Under such conditions this method is of course not practicable. Here one has to be guided by the means at one's command and by existing circumstances. During warfare with constantly shifting positions, not much can be done, most patients will succumb to the primary shock, plus circulatory and respiratory disturbance, or to a subsequent infection. About all one can do is to clean the wound in the thoracic wall as well as possible, cut away shreds of tissue and remove bone fragments and then insert a tampon and a large dressing. If an airtight cover is put over this the patient will certainly be more comfortable and a certain number will recover as the following case shows.

CASE 26. B. K., age 26, wounded March 14, 1916. While throwing hand grenades he was struck in the back by a fragment of an exploding shell. He felt a heavy blow and fell down. He wanted to speak but was unable to. Immediately he had severe dyspnœa; he says he felt as if he were paralyzed inside. He was carried to a dressing station, bleeding profusely from his mouth, and also from the thoracic wound. Air and frothy blood were passing in and out. He coughed incessantly. His condition was critical. The entrance wound was in the posterior right chest, region of eighth and ninth ribs. There was no wound of exit. The tissues were lacerated and infiltrated. The wound was cleaned and to stop the air passing in and out a tampon was snugly packed into the hole. A dressing was put outside of that and over the whole a firm adhesive plaster strapping. This brought great relief and improved the patient's condition.

The first dressing was changed 5 days later, because thoroughly saturated with blood and secretions. The temperature was fairly low, the general condition improved. The wound was found clean; therefore tampon was removed and the wound edges were sutured.

During the next few days the temperature gradually rose until it reached 103° and then 104°. Therefore, a change of dressing was made six days after the suture. Thin bloody pus was seen to exude from between the sutures. The latter were removed and considerable pus evacuated. A drainage tube was inserted. After this there was gradual improvement in the patient's condition. Hæmoptysis continued for only 2 to 3 days, but a distressing cough lasted about eight weeks.

When admitted to my service he had a fistula of the posterior thoracic region, secreting a seropus. A probe entered upward and inward for about 15 centimeters. An X-ray with the probe in place showed a shell fragment roughly 1 inch square near the tip of the probe. Under the impression that this piece of steel was the cause of the suppuration, I operated on the patient under general anæsthesia, about ten weeks after his injury. I made a large skin flap as for a Schede operation, removed the eighth and ninth ribs, which were fractured, together with a greatly thickened pleura and numerous small embedded bone fragments. A cavity the size of a large fist was entered. The walls were smooth and rigid. A search for the shell fragment proved negative. It seemed, therefore, that the suppuration was due, not to the piece of steel, but to this rigid old empyema cavity. To obliterate it I also resected the seventh, sixth, and fifth ribs, and then did a decortication of the lung. It expanded well as soon as released. Even then, with the lower lobe of the lung between my fingers, I was unable to feel the fragment and concluded it was embedded some place in the mediastinum. A small gauze strip was inserted and the wound then closed. The first few days after operation the patient's condition was bad, but then he improved rapidly and after almost four weeks the wound had entirely closed.

What the tampon in this case apparently accomplished was that it allowed the lung to form adhesions over it, thus preventing a general pneumothorax and a general traumatic empyema. Whatever infection did take place, was localized to the region below these adhesions. Unfortunately, however, such favorable results are not obtained in the majority of cases and for this reason many surgeons have looked for other ways to combat the condition.

To find the correct indication and treatment is not always easy, but in view of the commonly bad results in the treatment of open pneumothorax by conservative means, many surgeons have come to the conclusion that active surgical interference has to be resorted to if the surroundings warrant it. These favorable surroundings as to operating facilities and asepsis have been given in the position warfare now carried on at the West front. Numerous surgeons, chief among them, Sauerbruch, Landois, Burckhardt, and Jehn, now operate on their cases of open pneumothorax with the aid of a simple positive pressure apparatus.

As soon as the patient is admitted to the field hospital, he is prepared for operation. In case there is a small defect of the chest wall alone, the lacerated wound edges are excised and the hole then closed by suture.

If, on the other hand, the defect is so large that a suture cannot be done, the presenting lobe of the lung is drawn into view and sutured into the thoracic window by means of silk. No drain is inserted. A piece of oil silk, or just a moist dressing, is put over the exposed lung surface and wound, and then a large dry dressing outside of this. In case an empyema develops, it is treated by secondarily resecting a rib, preferably not before 7 to 10 days have elapsed.

If in addition to the hole in the chest wall there is an injury of the lung, this is attended to at the same time. The lung is drawn into view, the wound cleaned, foreign bodies removed, the edges freshened and then closed by passing fine silk sutures deeply through the lung substance. This portion of the lung is then sutured into the thoracic window, and a dressing applied over it. No drain is inserted because it always leads to secondary infection, and without it, it is possible at times to get primary union. The wound is left open and a secondary plastic done later. The reason for suturing the injured portion of the lung into the window is to facilitate drainage in case an infection of the lung should take place. It has been found that suturing the lung into the thoracic wound has several advantages. It prevents a complete collapse of the lung and by forming adhesions limits the infection of the pleural cavity should one take place. In case it does, it is treated by a rib resection, taking care not to disturb the sutures. By following this procedure, many lives have been saved.

In order to do these operations well, and with less danger to the patient, one should use one of the simple positive pressure apparatus. It does not matter much which particular one is used, as long as it can be worked by hand, for in the field hospital where it will chiefly come into play, no electricity or other driving force is available. The pump described by Dr. H. Fischer,[1] is very good and simple. This apparatus supplies an intratracheal anæsthesia. The catheter can be easily inserted through the larynx under guidance of the finger, and anæsthesia maintained for any desired length of time. The inflation or collapse of the lung is absolutely under control, and after completion of the lung suture the latter can be tested, the lung inflated and it will then immediately apply itself closely to the chest wall.

A type of injury not infrequently seen is a combination of a thoracic and an abdominal wound. The bullet coming from above may first pass through the thorax and possibly the lung, then perforate the diaphragm and cause laceration of the liver, spleen, stomach or other abdominal organs.

CASE 27. W. R., age 39, wounded March 26, 1916. When admitted about a month later he said he had been wounded by a shrapnel ball entering his right chest, four weeks ago. The wound healed promptly and he was discharged. He now complained of dyspnœa and pain in the right chest. The entrance wound of the bullet was found just below the tip of the scapula, and was entirely healed. Below this there was flatness of the chest and the respiratory sounds were absent. An exploratory puncture showed a turbid reddish fluid. May 4, 1916, aspiration of 500 cubic centimeters sanguinous fluid. May 11, 1916, X-ray shows pleura filled with fluid. Mediastinum displaced to left. Shrapnel ball seen, apparently in lower thorax. May 15, 1916, complains of pain in region of stomach and liver, and at times he has sticking pain at right costal border. Temperature varies from 100°–101.4°. May 18, 1916, still has pain in upper abdomen. Flatness in the chest reaches up to the middle of the scapula and axilla. The upper abdomen is tender. In region of the lower ribs there is œdema, stopping at the costal margin. The temperature did not rise above 102°. There was marked dyspnœa. Aspiration between ninth and tenth ribs shows pus; therefore immediate resection of part of ninth rib was done. About two quarts of thin pus was evacuated. While palpating the diaphragm a hole was felt; this was enlarged and the upper surface of the liver found covered with fibrin. A drainage tube was inserted into the subdiaphragmatic space and the diaphragm sutured around the tube. The pleura was drained separately. The bullet was not found.

The convalescence was uneventful. An X-ray taken subsequently showed the shrapnel ball in the liver substance. About a month later the patient's general condition had much improved. The secretion was less, but there was present an old empyema cavity and also a subdiaphragmatic cavity. He should be reoperated on to have the bullet removed in order to stop the liver suppuration and likewise to have a Schede operation for obliteration of the empyema cavity. I did not consider his condition sufficiently good to attempt it at this time and therefore postponed it.

[1] Surg., Gynec. & Obst., 1911, xiii.

In perforating injuries of the chest and abdomen caused by rifle bullets or shrapnel balls, in which the course of the canal would indicate that the stomach or intestines may be injured, a primary laparotomy should be done as soon as the patient is admitted. Good results are obtained this way. The thorax wound is treated conservatively.

If, however, the injury is caused by a fragment of shell and an open pneumothorax has been produced, it is better to do a transdiaphragmatic laparotomy. The channel is split and widened, the lung drawn down and sutured to the thoracic wound. Then the edge of the diaphragmatic wound is likewise sutured to the thoracic window, thus effectually closing off the pleural cavity.

Any injury done to the abdominal organs is then attended to through the diaphragmatic wound, and a tampon inserted. Should the pleura become infected, it is drained secondarily by a rib resection.

Left untreated, these cases have a very bad prognosis; they die of a general peritonitis or a suppurative pleuritis.

It not infrequently happens that injuries of other vital organs are associated with perforations of the thorax and lungs. They materially influence the prognosis, and may even be the more important factor in determining whether a patient is to be permanently disabled or not. The following few cases will illustrate such conditions.

CASE 28. A. R., age 22, wounded June 3, 1916. A rifle bullet entered the left chest between the sixth and seventh ribs in the midaxillary line, passed downward and backward, and came out over the spinous process of the third lumbar vertebra. He fell down and was immediately very sick. He bled a great deal from the wound of exit. He was dressed on the field and then carried to a dressing station where he was kept two days, his precarious condition making removal impossible. When he arrived there he was very pale, his pulse small and rapid, he had severe dyspnœa and complained of constant pain in the left chest and upper abdomen. He was left on his stretcher because of fear to move him, and was given morphine and caffeine every hour. He coughed a great deal but did not spit blood. Toward evening he passed bloody urine, and this continued in decreasing amounts for the next few days. Diagnosis: kidney perforation.

On the third day his temperature reached the highest point, 103.2°, and then gradually subsided. In addition to the usual symptoms of lung perforation, he had distention of the abdomen with marked tenderness and rigidity in the left upper region. However, this gradually subsided without forming an abscess.

Three weeks after the injury both wounds were firmly healed. He still has pain in the left chest on deep inspiration, but aside from a few râles there are no abnormal signs. He has no symptoms referable to his kidney. There is no nerve disturbance.

CASE 29. A. P., age 19, wounded June 10, 1916. A shrapnel ball entered his left lateral chest between the eighth and ninth ribs, tearing a hole 2 x 4 centimeters. It passed obliquely downward and to the right, perforated the spinal cord, and lodged in the depth. The patient fainted and when he regained consciousness he was unable to move his lower extremities.

The subsequent course was rather uneventful. He developed a moderate hæmothorax, which caused a temperature never above 102°, and which absorbed spontaneously. There was no hæmoptysis at any time; a cough continued for about a week. Two weeks after the injury, the wound was clean and granulating well. Physical signs in chest were slight.

An X-ray showed the shrapnel ball about two finger breadths below the right kidney. As the patient complained of pain in that region, I decided to remove it. I made an incision similar to the one for exposure of the ureter, and brought into view the lower pole of the kidney and the upper end of the ureter. The bullet was embedded within the peritoneum; by splitting the latter it was easily removed.

As far as the injury to the spinal cord was concerned, there were more bruising and hæmorrhage than actual destruction. Immediately after his injury, the patient was able to move the right foot, knee and hip, but was unable to lift the limb. The left one was absolutely paralyzed. There was no disturbance of bladder or rectum.

Gradual improvement continued to take place, however, so that three weeks after the injury he had gained full control of his right leg, and was also able to move the left ankle and toes. There was no sensory disturbance.

CASE 30. L. G., age 20, wounded March 27, 1916. A rifle bullet fired at a distance of 600 to 700 meters entered at the inner border of the right scapula, passed through the right lung and axilla, emerged at the posterior axillary fold and then passed through the forearm, entering at the radial and coming out at the ulnar border. It was a most extensive injury. While passing through the axilla, the bullet severed the axilla artery and injured the brachial plexus. The patient did not feel severe pain, it seemed to him that he had received a blow in the back. He did not faint. He jumped into the trench and went to be dressed, assisted by a friend. Immediately after being injured he felt his right arm hanging down helplessly by his side. He coughed

a great deal, had difficulty in breathing, but did not spit blood. On the transport wagon to the field hospital he felt severe pain in the chest and arm. In this hospital a rapidly increasing swelling of the right axilla was noticed; no tremor could be felt over it. The radial pulse was absent and arm and hand could not be moved.

Immediate operation (four hours after injury). Incision was made parallel to the lower border of the pectorales major. In the infiltrated axillary tissues the partly severed axillary artery was found and doubly ligated. The brachial plexus seemed cut, but for fear of disturbing the collateral circulation no operation was attempted on this. The arm was wrapped in cotton and paper.

Improvement set in at once and was continuous. A week later a slight radial pulse could be felt. The limb was warm, sensation was gradually returning, but there was absolutely no motion. His chief complaint was pain in the arm, often very severe. There were no symptoms referable to the chest.

When admitted to my service about a month after the injury, there were no signs in the lung. The wounds had healed. The arm was helpless and the patient complained of considerable pain, often shooting in character. By keeping the limb warm, giving light massage and warm baths, slow but steady improvement could be noted, so that three months after the injury the following status could be recorded.

The pain has stopped. There is now only a prickling sensation. The color of the upper arm is good, that of forearm and hand dusky, especially on dorsum. There is no anæsthesia of the arm, forearm, or hand for pin point, cotton or temperature.

Hyperæsthesia is present over the lower ventral surface of the forearm and palm of the hand. The patient is able to elevate both shoulders equally, abduct the arm, and slowly put it behind his back. Flexion and extension of elbow are possible to a degree, limitation probably due to non-use. Motion at wrist is absolutely impossible, except that he can flex the wrist slightly if resting it on the dorsum. He can move all fingers slightly in direction of flexion, and can also extend the tips of the fingers somewhat. He is unable to spread them at all.

The patient had a hard firm band-like scar running from his axillary scar into the depth. In the hope of improving the function of the hand by removing this scar, I operated on him three months after the injury.

I laid the axilla wide open and removed the scar tissue running from the skin inward. It was adherent to the brachial plexus and the ligated portion of the axillary artery. In the upper part of the axilla, the artery was distinctly felt pulsating; likewise, about three inches further down on the upper arm, the ligated intervening portion was collapsed and not pulsating, but had not been converted into a fibrous cord. All the nerve trunks were red and congested. I could not identify the individual strands positively, nor could I find that any one of them had been severed. After carefully cleaning each nerve trunk, I covered the whole with a flap of fat to prevent re-formation of scar tissue, and then closed the wound.

During the short time that patient remained in my care, no appreciable change could be noted.

SUMMARY

1. Perforating gunshot wounds of the thorax and lungs with a closed pneumothorax or without one, should be treated conservatively.

2. Hæmothorax producing alarming symptoms of compression should be aspirated early, removing just enough fluid at first to relieve the symptoms.

3. Hæmothorax running a normal course but showing no or little tendency to absorption, should be aspirated to prevent the formation of a thickened pleura, contraction of the lung, etc.

4. An infected hæmothorax should either be aspirated at first and later have a rib resection, or, if the symptoms are urgent, the rib resection should be done at once.

5. An open pneumothorax with a small external opening should be closed by suture if the wound is clean, otherwise by a firm dressing or a tampon.

6. An open pneumothorax with a large opening should promptly be treated surgically. If only the thoracic wall is injured, the wound edges should be excised, and the lung sutured into this window. In case the lung also has been perforated, this wound should likewise be excised and sutured and this portion of the lung then fastened into the thoracic window.

7. In order to do these operations satisfactorily it is advisable to have a simple positive pressure apparatus at hand.

IS THE PURGATION OF PATIENTS BEFORE OPERATION JUSTIFIABLE?

A Clinical and Experimental Study

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As is well known, it is a common custom to prepare patients for surgical operations by purging them. The writer has been so impressed at various times by the harmfulness of this procedure that he has come to question whether it is really necessary, and if so, why. A review of the literature and the questioning of surgical friends alike have failed to elicit satisfying answers to these queries. When asked why he purges before operations, the average surgeon says that he wants the stomach and bowel empty when he cuts into them, as in a gastro-enterostomy. That fails to explain why he prepares in the same way for a tonsillectomy, for the removal of a breast, or the amputation of a finger. Besides, as is well known, he does not depend upon finding the viscera empty, but uses clamps in all gastro-intestinal cases. With these clamps, it does not make much difference whether there are two or six ounces of fluid in a stretch of bowel. As Mayo has pointed out, the difficulties and dangers of using such clamps in the colon are *increased* by purgation. It can easily be seen that the chances of soiling the peritoneum are greater with liquid than with solid fæces (1).

Moreover, the surgeon must know that the small intestine is empty in from 7 to 9 hours after a meal. In seven years' experience in radiographing the digestive tract, I have seen perhaps a dozen cases in which the ileum contained food after fifteen hours (2). Since operations are usually performed in the morning, from 12 to 18 hours after dinner, there is certainly no need for giving a purgative to clear the small intestine. The only place left in which fæces can stagnate is the colon; and, in most cases, that also would empty itself spontaneously on the morning of operation, if it were left alone. Failing this, it could easily be cleared by enemas. I have convinced myself by radiographing patients after they have taken an enema to clear out barium-containing fæces, that the colon can be emptied very thoroughly in this way. It would seem, then, that the preparatory purgation can be dispensed with, if its only object is the emptying of the bowel; enemas would serve just as well.

The anæsthetic. When "cornered" by these arguments, some surgeons have taken refuge behind the skirts of the anæsthetist — they have said that her work requires the preparation. Apparently they do feel this way, because when a man applies a cast in his office, he doesn't think of preparing the patient, but if the same thing is done in a hospital, after the administration of a little ether, purgation is deemed essential. I immediately questioned some of the leading anæsthetists of this city, who promptly disclaimed any desire for pre-operative purgation of their patients. They had not observed any difference between the behavior of emergency and "prepared" patients so long as their stomachs were empty.

Fear of auto-intoxication. Other men have expressed a fear that the presence of fæces in the bowel might lead to the absorption of toxins. Here, again, I would suggest that there is no need for alarming ourselves over something that has never troubled the majority of people. Why should we be worrying about "auto-intoxication" in a patient whose bowels have always moved regularly, or who feels none the worse for four or five days' constipation? The surgeon may answer that he fits the preparation to the case: that such patients are not purged; but from conversation with head nurses and a perusal of the instruction sheets tacked up in some busy hospitals, I fear that such discrimination is not often employed. If there is to be any absorption of toxins, it seems more reasonable to suppose that it would be from churned

liquid contents and not from dry masses lying quietly in the gut (3). Besides, the bacteria in solid fæces are for the most part dead, while those in the liquid dejections are alive and possibly increased in virulence. Karl Meyer tells me that solid fæces tend to restrain the growth of pathogenic bacteria in most people. For instance, in typhoid carriers, it is practically impossible to cultivate bacilli from solid stools, but if a purge be given, the liquid fæces may be found swarming with typhoid bacilli. The flora of the liquid stools will be quite different from that in the solid stools of the same person; perhaps because the colon bacilli lose some of their restraining effect on other more pathogenic bacteria. Thus, cocci isolated from solid fæces generally appear in clumps, while those from liquid fæces tend to grow as streptococci.

Normally, these bacteria cannot go through the mucous membrane of the gut, but those who have studied this problem in various ways agree that it does not take much to upset the protective mechanism, or to break down the barrier. Thus, in dogs, slight abrasions of the superficial mucous membrane, produced by round-worms, are enough to let the bacteria through to the mesenteric lymph glands or beyond (4). Booker concluded that anything producing excessive secretion of the intestinal glands is likely to open up paths of entry (5). Ficker found fatigue or starvation for a few days would let down the bars (6). Meyer found that a number of his rabbits that were purged developed positive blood cultures. These experiments are enough to show that the mechanism which protects our bodies from invasion by intestinal bacteria is a delicate one; and it would seem wise not to meddle with it before operations, by starving and purging. Such "preparation" is just as likely to increase the dangers from "auto-intoxication" as to diminish them. Certainly we know that many people feel miserable and poisoned for a few days after purgation; they are weakened and feel below par.

Fear of gas pains. Another motive back of the so-called preparation is the desire to avoid gas pains. Unfortunately, most physicians seem to have the idea that flatulence is due primarily to the fermentation of intestinal contents and that it can be stopped by cleansing the bowel. The work on experimental ileus shows that this is not so. Kader, in his interesting monograph (7), has pointed out that there is little difference in the amount of gas accumulating in isolated loops of dog's small intestine which have been filled with material expressed from adjoining loops, or emptied and washed out with physiological salt solution. Very little gas was found in either case unless the circulation was interfered with. If the mesenteric arteries or, more particularly, if the veins were tied, the loops soon became enormously distended. Leichtenstern has pointed out also that in man, the tremendous accumulation of fæces above a slowly formed stenosis of the colon is not generally associated with meteorism, while on the other hand, a little patch of peritonitis, or a pinching or incarceration of a small loop of bowel will, in a few hours, give rise to an enormous tympanites (8).

The thing to be desired is not a clean bowel but a *normal mesenteric circulation.* A number of investigators have shown that the large amounts of gas constantly being formed in the bowels of herbivorous animals are as rapidly carried off by the circulation and excreted by the lungs (9). The delicate mechanism underlying this process can easily be overthrown by upsets in the motility of the bowel, by disturbances in the circulation, or by changes in the secretory and absorptive functions of the mucous membrane. One would think that the last thing the surgeon should want to do would be to tinker with this mechanism before an abdominal operation. Schierbeck, Woodyatt and Graham (10) have shown that the blood may not only fail to carry the gas away, but it may even *exhale* some into the bowel. Such an exhalation would account best for the sudden accumulation of gas so frequently seen in man.

It is common knowledge that in many sensitive people, purgation will be followed by alarming flatulence and distention. This tendency for the bowel to fill up with gas after a purge is very annoying to the radiologist when he tries to prepare his patients

for gall-bladder or kidney plates. Many have discontinued such preparation as they "consider that the gas resulting from the cathartic is a more disturbing factor in the interpretation of the roentgen plate than the fæcal contents of the colon" (11). Surgeons have confessed to me that some of their patients have almost died from pseudo-ileus and abdominal distention when the abdomen had not been opened at all. In one case, a large, healthy looking man entered the hospital to have a cast applied for his back. When he discovered that he was supposed to submit to standing orders and take a dose of castor oil, he called up the surgeon (one of the best known men in the West) and told him that he never was constipated, and that laxatives always upset him fearfully. The doctor insisted that preparation was essential, so the patient was purged violently for two days. He then became so distended with gas that his life was temporarily dispaired of, and the cast was removed barely in time to save him. If purgation will do this when the abdomen is not opened, how much more likely is it to endanger life when the bowel has suffered the added insults of handling, exposure, and sewing?

Fear of peritonitis. Emmet Rixford has suggested to me that the practice of purgation before operations may have originated among the early American gynecologists. These men feared peritonitis a great deal, and as Thomas says, if this should occur and the bowels have to be kept bound for awhile, it would be well to have them empty and ready for the storage of fæces. Thomas purged his patients every other day for a week preceding operation (12). Such ideas should not influence the modern surgeon who has so much less to fear from peritonitis. Now that his main concern seems to be just the opposite, i.e., to have the bowels move shortly after the operation, we should expect he would plan to leave some material in the cæcum to facilitate the resumption of colonic activity. With a strange inconsistency, the surgeon often insists upon a movement on the fourth day when he has done everything in his power to prevent it by first cleaning the patient out, and then by withholding food — particularly food that will leave a fæcal residue.

The origin of the idea of preparation. After studying the answers given by my surgical brethren and after reviewing the literature, it seems to me most probable that the practice has arisen from a vague idea that *something* ought to be done to get the patient into good condition. The idea was well expressed by a woman who once refused to take an injection of salvarsan because she had not been given a course of calomel beforehand. When it was explained to her that such was not the custom, she said she would have to look around and find a doctor who would put her on a special diet, who would starve her, or do *something* in the line of preparation. She was sure that no such serious procedure should be submitted to without preliminary treatment.

Now where can such a deep-rooted and wide-spread idea have originated? We may be sure that it will be found running far back into the history of medicine, because the housewife's ideas of one age are echoes of the best medical theory two hundred years before. A little reading soon convinced me that this desire for preparation must be a relic of medical practice two thousand and more years ago. The idea can be traced back through humoral pathology and even to the dawn of history. In groping around for a cause for disease, primitive man reasoned that if fæces and vomitus are foul, the body must be in the best condition when most free from these substances. As Burton (13) tells us in his *Anatomy of Melancholy* (1621), purges "scour the body of vomit, urine, sweat, of all manner of superfluities, and keep it clean." According to Herodotus, the Egyptians took an emetic and a purge once a month to keep in good condition, just as many people now take a dose of calomel. Galen (14) had the idea that "every purgative, by some specific property, attracts and, as it were, sucks to it the humor to which it has a natural alliance, in like manner as the magnet attracts iron." Haly Abbas went still further. He maintained that the purge "goes to the part where its cognate humor is lodged, from which both are expelled and returned to the bowels

together" (15). Burton also speaks of giving "clysters and suppositories to draw the humor from the brain and heart to the more ignoble parts" (16). Later writers took these theories and added to them. The following quotations are offered as samples of medical thought a hundred or more years ago. In the first English *Practice of Physic* printed in 1776–1798, Cullen (17) says: "Purging has the effect of diminishing the activity of the sanguiferous system, and of obviating its inflammatory state!" Another physician writing in 1819 says: "The stimulus of purgative action at once energizes the languid and torpid state of vital power . . . and induces actions . . . that directly conduce to invigorate and amend a weakened or diseased state of the parts" (18).

One can easily see why men holding such views about purgatives should give them to healthy persons who were about to undergo some ordeal, and who wished to be in the best possible condition. We find that they purged those starting on a journey, those who were to be bled, and those who were to receive emetics (19). Burton tells us that they even prepared the patient who was to be purged by giving him so-called lenitives and preparatives (20). Carneades, the Academic, purged himself before entering upon a debate with Zeno, the Stoic (21). His idea was that if hellebore, the drug used, sometimes cured madmen, it should sharpen the wits of the sane. Naturally, when inoculation came into vogue, the candidates were purged. It is interesting that as early as 1776, Cullen questioned the value of "*these pretended preparatory courses* of medicine" (italics mine). He remarks that "other mischievous effects have sometimes appeared" (22). Jenner apparently had too good sense to advise purgation before vaccination, although others did "prepare" their patients (23). A young American medical student (24) who was in London in 1801 writes: "When inoculated, Woodville gave these people five grains of rhubarb and ordered five grains more to be taken in about a week, *principally to quiet the parents*!" Men who were to be tortured for the extortion of confessions were prepared by the giving of purgatives (25). Although it was believed that if the accused were innocent, God would stand by him and make his suffering so bearable that he would not have to perjure himself, it was thought best to have him in as good physical condition as possible.

It was not so easy to find references to purgation before operation in the earlier works on surgery: perhaps because such books deal almost entirely with wounds and fractures. One of the few non-emergency operations done by the ancients was the removal of the cancerous breast. Let us see why these patients were purged. Galen held that the cancer would not have grown if the function of the part had not been depressed by an evil humor such as black bile. This had to be purged away before surgery could have any prospect of success. These theories were still current in the time of Ambrose Paré (26).

Some may say: what is the use of dragging in all this ancient history; those ideas cannot influence us today. Let us not be too sure of that; let us see when they were given up, and why. I, personally, had never realized how enduring these old theories were until I found the learned Doctor Adams, in 1847, seriously discussing the pros and cons of some ancient quarrel between Galen and his successors (28). The fact is, that humoral pathology could only be downed by exact knowledge gained at the autopsy table and in the laboratory. It is hard to realize how recently this change has come. Even Rokitansky's great work on pathology, written in 1842-1846, was marred by "his attempt to revamp the ancient drivel about solidism and humoralism" (29). It was left to Virchow (1846) with his *Cellular Pathology* to break away entirely from the old ideas. Pasteur applied his research to medicine and laid the foundation of bacteriology in the years from 1877 to 1885; and Lister devised antiseptic surgery in 1867. Ideas which have been held for two thousand years cannot be uprooted entirely in seventy years, and no student of history will doubt that they are influencing us today. Practices always tend to persist long after the motive is forgotten. If this practice of purging before operations is really based upon humoral pathology, it should be given up (not mitigated), unless it

can find new support in physiologic and pharmacologic research.

Preparation is being given up. If purgation is really a good preparation for an ordeal, if it "energizes the vital powers," why isn't it employed by athletes? Why doesn't the college trainer give the track team a dose of salts all around the night before the big meet? Any one who has been in athletics knows that that is about the last thing on earth he would do. As Oliver Wendell Holmes (27) says: "If it were known that a prize-fighter were to have a drastic purgative administered two or three days before a contest, . . . no one will question that it would affect the betting on his side unfavorably." He goes on to say that if this be true for a powerful man in perfect health, how much more true it must be of the sick man battling for his life.

The fact that the most serious and complicated operations are done successfully in research laboratories on animals which are not purged, shows that there is nothing in the operation itself that necessitates such preparation. Still more convincing is the argument that nothing but good results have followed the abandonment of routine purgation in human cases (30). I have talked with a number of busy surgeons who, for years, have not been purging their operative cases, and who are all enthusiastic about their improved results. They all comment on the greatly decreased amount of vomiting, flatulence, dynamic ileus and gas pains. Very significant also is the fact that others who still "prepare" have made the process much milder. Where it used to be ten grains of calomel and ten grains of jalap, or two compound cathartic pills, it is now a laxative or an ounce of castor oil given 48 hours before operation, so that, as the surgeons admit, the patient will have time to recover a little. When a review of the literature showed this marked tendency of surgeons all over the country to diminish the severity of purgation or to discontinue it altogether, I began to question the need for writing this article. Further investigation showed, however, that there are some reactionaries who are pleading for a return to drastic preparation, and claiming that it is a sure cure for all postoperative troubles (31). Another thing that has induced me to publish at this time is the fact that a number of surgeons, particularly those in the country, have told me they did not dare say anything about having given up preparatory purgation for fear that, in case of accident or of a damage suit, they might be condemned for their unwarranted innovations. It is interesting that almost all of these men state that they gave up the routine purge at the suggestion of their nurses, who kept asking why it is that emergency appendicitis cases have such quiet postoperative courses as compared with the well-prepared "interval" ones. During the last four years I have questioned a large number of experienced nurses, asking them which they would prefer looking after, an emergency or a prepared abdominal case, and the answer has always come back unhesitatingly: "The emergency case, of course." They have all agreed that the stormiest aftercourses and the worst gas pains are met with in the elaborately prepared cases.

EXPERIMENTAL WORK

It was with the hope of throwing a little experimental light on this subject that Mr. Fletcher B. Taylor and I undertook some work on purged animals. It seemed reasonable to suppose that if purgatives have either tonic or depressant effects on the gut, these effects should be demonstrable in the excised segments, which will contract rhythmically in warm oxygenated Ringer's solution. I was interested to see if any change could be shown in the gradients of rhythmicity, irritability, or latent period. I have suggested elsewhere that the downward progress of food through the tract depends largely upon a gradient of muscle forces, of irritability, and rhythmicity, i.e., the upper part of the bowel not only contracts more powerfully under stimulus, but it reacts more promptly and beats more rapidly than do the parts lower down (32). The intestinal contents move from the more active, irritable regions above, toward the more sluggish, less irritable regions below. It can easily be seen that the regular, uninterrupted progression of material in the bowel must depend on the smoothness of this

gradient. An upset in the gradient might occur if the purgative should happen to depress or fatigue the upper end of the intestine more than the lower (33). Even a general uniform exhaustion of the muscle might be a serious complication after a laparotomy, when the surgeon often wants the bowel to react promptly to carminatives or purgatives. So often the deplorable state of a patient is due to the fact that when the postoperative purge fails to act, stronger and stronger ones are given and are retained.

A full report of the experiments will be published elsewhere.[1] Rabbits were used because excised segments from their intestines contract so regularly in Ringer's solution that deviations from normal are easily detected. In spite of conditions which are ideal for fermentation, the intestine of the normal rabbit contains practically no gas; the walls are tonic and grasp their contents firmly. Five animals received castor oil; four, magnesium sulphate; five cascara; three, calomel; and three, compound tincture of jalap. For the most part, mildly laxative doses were used. If the animals had been purged to the extent that patients are purged, the changes in the bowel would probably have been more striking. The drug was given about noon, and the animals were killed the next morning at nine o'clock. Segments for study were taken from five different places in the bowel. Six well purged animals were apathetic and looked sick. The bowels of these animals were injected, full of fluid and gas; sometimes atonic and flabby, often irritable here and there, and inclined to contract down into hard white cords. When the excised segments were put into the warm Ringer's solution, their contractions were weak and irregular, and they soon became fatigued. They were less sensitive to some drugs applied locally; in some cases, the doses had to be increased one hundred times to produce any effect. The importance of this observation will be evident to the man who knows how difficult it is to make the bowel respond to drugs after purgation (34).

Of seven moderately purged animals, six showed some intestinal gas or other abnormality. In three, the segments contracted poorly. Some of the animals which received doses too small to produce purgation were also full of gas and showed signs of intestinal paresis.

From these observations, magnesium sulphate would seem to be the most objectionable purgative for the surgeon. On account of its well known action in preventing the absorption of water by the bowel, the intestines in the animals purged by this drug were distended and full of fluid. Calomel and cascara did not seem to poison or fatigue the segments as did castor oil, magnesium sulphate and jalap. With calomel, the segments beat well with a large amplitude and slow regular rhythm.

The gradient of rhythm in the excised segments was irregular only in the animals that received castor oil. Probably this gradient would have been found to be more upset if it had been studied in the intact intestine with the animals opened under salt solution. Records obtained in this way from diarrhœic animals showed very irregular gradients of rhythm (35). More striking deviations from normal were found when the latent periods of the segments were studied. Normally, there is a certain gradation from short latent periods in the duodenum and jejunum to longer ones in the terminal ileum. In the purged animals, some segments were more irritable than normal, and had shorter latent periods; while others would hardly respond at all to the strongest current. Colic and gas pains might be due to the distention of such paralytic regions by gas forced into them and held there by more irritable and powerful loops above and below. In the normal intestine, the gas, if not immediately absorbed, would promptly move aborally because the oral end of the loop would be stronger, quicker and more irritable than the aboral end.

The injection of the intestinal wall and the engorgement of the mesenteric vessels noted in many of the rabbits deserves mention. It has been observed after purgation in man. Such a disturbance in circulation might upset the delicate balance between the gases in the intestine and those in the blood.

[1] Alvarez and Taylor. J. Pharm. & Exp. Ther., 1917, x, 365.

SUGGESTIONS

That this paper may not close with purely destructive criticism, the following suggestions are offered. They have all been put into practice by surgical friends whose reports so far have been encouraging. Naturally, it is not to be expected that the measures recommended will entirely eliminate gas pains. Much will always depend upon the nature of the operation, the constitution of the patient, the amount of ether used, the amount of peritoneal drying, and the gentleness or roughness of the operator.

Unless there is serious gastro-intestinal stasis from obstructing lesions at the pylorus or in the bowel, the patient should eat his usual dinner. As Crile says: "It is a serious mistake to starve a patient too long (or to purge too severely) before an operation" (36).

Unless the operation is set for an early hour in the morning, he may sleep in his own bed the night before. If he is very nervous and apprehensive, he had better take a full dose of adalin or other soporific to insure rest.

If the operation be set after 10 a. m. and if there be no lesion causing gastric stasis, a breakfast may be given consisting of the patient's usual coffee with a roll or some toast or a plate of smooth mush. No physiologist would ever expect to have an animal's bowel tonic and in good condition for class demonstration or for research experiments unless food had been given that morning (37). Mr. Taylor and I studied excised segments from four rabbits starved for four or five days, and found the contractions diminished in amplitude and strength. Ordinarily, a light breakfast should leave the stomach in two or three hours. In patients with duodenal ulcer, gall-stones or achlorhydria, most of it would probably be gone in an hour. Experience alone will show whether or not this suggestion is practical and the results worthy of the extra trouble. It is very possible that fear and apprehension will so lengthen the emptying time in many people that food will remain to interfere with the action of the anæsthetic.

If the patient's bowels move normally every day, and particularly if they move on the morning of the operation, as they probably will do if the breakfast is allowed, no enema should be given. Enemas need be given only to those who are definitely constipated, or who are to undergo operation on the lower colon or on the pelvic organs.

Gas-oxygen should be used when possible, as it upsets the digestive tract very much less than ether does.

Solid food should be given as soon after operation as possible, on account of its tonic effect on the tract, and its tendency to restore the downward currents (38). The thing to be avoided is the cellulose in fruits, salads and green vegetables. Give the patient all the water he wants. Unless it is very cold it will not stimulate peristalsis very much. It certainly cannot do harm in the lower bowel as it is absorbed so rapidly in the duodenum and upper jejunum. Given freely, it often stops vomiting; it washes the stomach; it lessens the dangers of retching, as vomiting is made so much easier; and a considerable amount of fluid will generally be retained (39). This enables the surgeon to dispense with the Murphy drip, which undoubtedly tends to keep up reverse peristalsis, and in many cases is largely responsible for the nausea and gas pains. Weeks' article on the subject is timely (40). He might have added that this apparatus is being used more and more as a fetich, after short operations in which there has been no loss of fluids and no shock.

Avoid postoperative purgation; certainly do not give it as a routine on the fourth day. So often the patient's after-course is uneventful until this dose is given. There is no harm done if his bowels do not move, especially if he hasn't been getting much food or if he were purged beforehand (41). McPherson (42) has shown very conclusively on 644 consecutive cases that the routine purgation after confinement is not only useless but harmful. The women were placed alternately in Wards A and B. Those in A had no catharsis; those in B were subjected to the usual routine. Of the 322 in Ward B, 28 had some fever (over 100.4°) during the puerperium; of the 322 not purged, only 3 had fever, and one of these had a mammary abscess. A considerable number of the women

who were left alone had normal bowel movements; others were given an enema every third day. None of them had any of the symptoms supposed to go with auto-intoxication. There was less danger from infection by the spreading of loose movements over the vulva. The mothers were saved much discomfort and the nurses endless labor. McPherson rightly concludes that the lowgrade fever of the puerperium can be due to the catharsis: to the stirring up of the colonic bacteria and not to any constipation.

Many surgeons will probably answer that some of their postoperative patients would have died with intestinal paralysis if they had not employed heroic measures and had not forced a bowel movement through. Rixford tells me that after years of consultations on such cases, he is satisfied that the purges do not *cure* the desperate cases; when they succeed, they simply show that peritonitis, if present, was not extensive enough to preclude recovery. If the intoxication is severe enough, the bowels will never move again and the patient will die no matter what is done (43). If the purge is simply a test to distinguish between the curable and the incurable, we ought often to restrain our curiosity, as the testing sometimes takes away the little chance the patient did have for recovery.

The prompt use of salines after operations is due largely to the teachings of Lawson Tait. He maintained that we must begin active purgation the minute distention appears. No time must be lost, because later, the purge may not work. He admitted that he had no right to say that he cured peritonitis, "but this I do know, that the moment we see distention we purge, and if we succeed in purging, the patient recovers; if not, she dies. Therefore, I am content to say that at least *we prevent peritonitis* (italics mine), and it is for that purpose that my routine treatment is directed" (44). Whatever we may think of the practice itself, it would seem that an antivivisectionist, a man who in 1892 could sneer at the "fashionable germ theory of disease" and who thought peritonitis was due to "a disturbance of the ebb and flow of the serous stream in the peritoneum" is hardly the one to be directing the thought of physicians in A. D. 1917.

SUMMARY

To sum up briefly, the reasons for avoiding purgatives before operations are:

1. Some of the purgatives owe their effects to the fact that they are irritant poisons that must be removed quickly from the body. Others act by interfering with intestinal absorption and by upsetting the balance of salts. In either case they bring about pathological conditions. The body is weakened and not strengthened.

2. We know now that the dehydration of the body and the upset in salt balance are bad, particularly before an operation in which there may be hæmorrhage and vomiting.

3. With magnesium sulphate, there may be an increased amount of fluid in the bowel to disturb those who want it empty. In operations on the colon, liquid contents are harder to control mechanically than are solid masses.

4. There is an increased growth of bacteria. There is some evidence that there is an increased absorption of toxins, and a greater permeability of the mucous membrane to bacteria. Undigested food may be carried down into the colon to supply increased pabulum for the bacteria.

5. By weakening some parts of the bowel and making others more irritable, the even flow of material from stomach to anus is rendered impossible.

6. Whether from disturbances in motility, in absorption, in the circulation, or in the bacterial conditions, there certainly is a tendency to flatulence and distention.

7. When the bowels must move frequently during the night, the loss of sleep is considerable. The purgation is particularly trying if the patient is wearing a large cast, has a broken leg, or other painful lesion which makes each resort to the bedpan an ordeal.

8. If the patient should happen to have some intestinal obstruction, a gangrenous appendix, a badly diseased Meckel's diverticulum, or adhesions forming around some pus, purgation may directly cause death.

9. Purgation makes the bowel react so poorly to drugs that there may be grave difficulties in meeting postoperative emergencies.

10. Emptying the bowel by starvation and purging makes the resumption of colonic activity much more difficult. The colon must be filled and distended to a certain extent before it will empty.

11. The fact that children and nervous women will sometimes begin vomiting during the night, *before* the operation, shows that the purge must be responsible for some of the postoperative nausea and vomiting. The ether adds the finishing touches to what was begun the night before.

It is suggested that food be given as late as possible before operation; that even enemas be avoided if not absolutely necessary; that water and solid food be given by mouth as soon after operation as possible; and that purgatives be avoided after operation as well as before.

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LIGATION OF THE SPLENIC ARTERY FOR BANTI'S DISEASE

Report of Case, Experimental Studies[1]

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SURGERY of the spleen is rapidly assuming a definite rôle in the field of abdominal surgery. Its removal was a recognized operation among the ancient Romans and Greeks and, at intervals, during the middle ages. It is not the purpose of this paper to review the history of voluminous literature of splenic diseases or a discussion of the present chaotic classification (1), but to consider a method of treating or disposing of the spleen in cases where it is the basic pathological factor and its removal is deemed necessary. The removal of the spleen will effect a cure in some maladies (2) and its indications are constantly being broadened (3).

CASE REPORT

Mr. P., age 38, Greek, laborer, was admitted to Harper Hospital, March 15, 1913. Temperature 98.2°, pulse 80.

Complaint. Pain in left side over region of stomach and spleen. Enlargement in upper left abdominal quadrant. Shortness of breath, general weakness, unable to work for past two months. *Family history.* Father and mother dead, cause unknown, wife in good health. Three sons and one daughter, ages 7, 10, 13, are in good health. In 1894 had attack of "rheumatism" involving shoulders, elbows and wrist respectively. The joints were red and painful but movable to a certain extent. He had had similar attacks in the fall of every year. Has never had chills or fever.

The patient dates the present trouble since 1894 when he first noticed the tumor on the left side. Since then it has been gradually getting larger. There is shortness of breath more marked of late, also pains in side. He has not been constipated, his appetite is good, he has never been troubled with indigestion. Physical examination disclosed a large tumor filling the whole left side of the abdomen and extending about three inches below the umbilicus. The splenic notch could be felt very plainly which left no doubt as to the organ involved.

Urine: Specific gravity, 1012, negative.

Blood examination on admission showed erythrocytes, 3,840,000; leucocytes, 5,555; polymorphonuclears, 58; large lymphocytes, 5; small lymphocytes, 35.5; eosinophiles, 1.5.

No plasmodia found. Hæmoglobin, 70.

Stool, occult blood negative.

A diagnosis of Banti's disease was made and as the liver was normal and the patient was free from ascites, splenectomy was decided upon.

Operation, March 25, 1913. Ether anæsthesia. Incision through left rectus 13 centimeters. The spleen, was enormous there was no free fluid, the liver was slightly enlarged, the spleen free on the anterior surface but firmly bound on the posterior surface and to the diaphragm. The veins from the spleen were enormously dilated and extremely thin.

Splenectomy was considered too hazardous after attempting to divide some of the adhesions and I decided to ligate the splenic artery. William Mayo (4) suggested (1910) the possibility of controlling the amount of secretion from the spleen by ligation of an arterial division as is done in the thyroid for hyperthyroidism. However, this or the destruction of the whole organ by ligating the artery had never before been attempted in the human subject. The artery was caught about 3 centimeters from the spleen, clamped in a hæmostat and ligated with chromic catgut in two places. There was an immediate shrinkage of about one-fourth in the total volume of the organ. The wound was closed without drainage.

The patient reacted promptly but on the second day the temperature gradually rose to 102° and the pulse to 140. That evening he developed moist bronchial râles, was much distressed in breathing, and had a slight cough, which was infrequent, suppressed. Morphia was given once during the second day for pain. On the third day he started to improve, the pulse and temperature became normal and the patient started to expectorate white frothy mucus. The patient was up in chair on the twelfth day and allowed to walk out of the hospital on the seventeenth day with wound entirely healed.

He reported to my office a few days later (April 20, 1913). His temperature and pulse were normal but a slight painful bulging was noted in the center of the wound. This was opened with a hæmostat and a large amount of broken down splenic tissue exuded from the wound. The wound was dressed frequently and finally healed in about six weeks. The hæmoglobin rose to 90 at this time and he said he was stronger than before operation.

[1] From the Department of Surgical Research, Detroit College of Medicine and Surgery. Submitted for publication, December 22, 1917.

Fig. 1. Roentgenogram of normal postmortem spleen (injected) showing distribution of arteries.

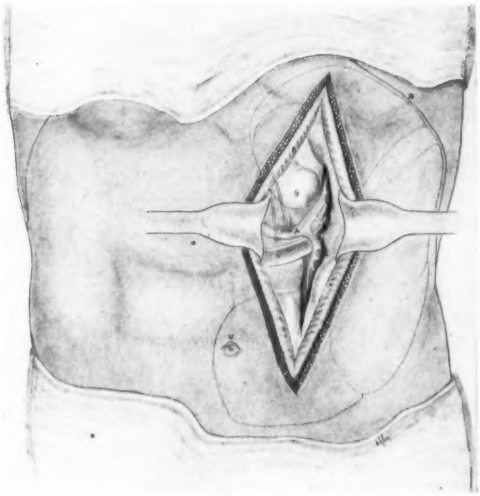

Fig. 2. Drawing illustrating ligation of the splenic artery. *D*, Diaphragm, *S*, spleen, *A*, artery, *V*, vein, *U*, umbilicus.

The patient said he was cured and returned to light work before the sinus was completely healed. It is now over four and one-half years since operation and the patient has remained entirely well and is doing heavy work.

As might be expected I was severely criticized by some of my colleagues at the time but I firmly believe the patient would have died had I attempted to remove the organ.

EXPERIMENTAL STUDIES

In the summer of 1913 I began a series of experimental studies on dogs, rabbits and guinea pigs. The latter were soon discarded owing to the technical difficulty in such small animals. Twelve dogs were operated upon at this time. In six cases the artery was ligated; in four the veins; and in two part of the arteries.

In the spring of 1917 I began a second series of experiments. These were carried out by a student assistant and most of the dogs died in about ten days due to some technical error.

This was followed by a third series of twelve dogs: six ligations of the artery, four of the veins and two of the veins and artery. Jamieson (5) of New Orleans has carried out some like experiments on dogs.

We will eliminate the second series from our work as the postmortems in many cases showed that the artery itself had not been ligated. None of the animals died in the first or third series and only some of them were subjected to secondary operation.

In the ligation of the artery there is an immediate shrinkage in the spleen pulp, while in the ligation of the veins a swelling too near double of the total size and weight of the gland. The animals do not seem to suffer any pain but are quite drowsy and thirsty on the second and third day. All of our work was done under strict antiseptic methods and the wounds except for superficial stitch infection remained clean. Silk as a suture material was used as a matter of routine. Some of the animals of the first series were kept under observation for more than a year.

The following conclusions were drawn from the experimental work: If strict asepsis (or antisepsis) is observed the operation of ligation of the artery or veins of the normal spleen in dogs can be carried out without mortality. In the work of Jamieson above referred to, the splenic pedicle was ligated and only four of his dogs survived over a

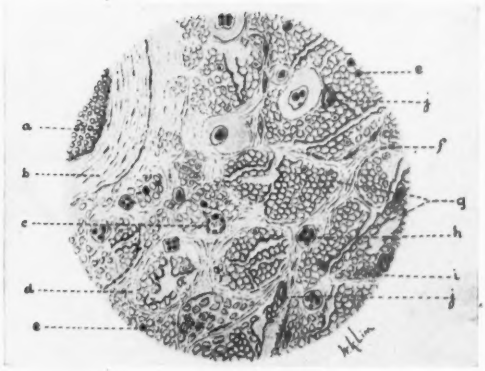

Fig. 3. Section of dog's spleen ten days following ligation of the splenic vein, showing slow pressure atrophy. *a*, Splenic vein, *b*, trabecula, *c*, phagocyte, *d*, venule, *e*, erythrocyte, *f*, endothelial cells, *g*, splenic pulp, *h*, polymorphonuclear leucocytes, *i*, pigments. Microscopically there is a striking change in the structure of the spleen from the normal. The cells and the arteries and their branches especially show a marked shrinkage. There seems to be no line of demarcation existing between the nodules and the pulp. The entire section looks like a mass of pulp with its reticular structure and blood spaces. The venules are not so clearly defined as in the normal, with endothelial cells around them, but instead are considerably broken up. The trabeculæ are very much enlarged due to the distention of the splenic veins in them, and no where in the section are they seen remaining intact.

week. As two of his dogs died within a few hours from shock and hæmorrhage, the operative technique is open to question. He has also noted that in the dogs which recovered the omentum was firmly wrapped about the spleen. We have observed this in all of our cases. In a second series of 5 dogs he wrapped the omentum about the spleen after ligating the splenic pedicle, and the dogs recovered.

Our work was confined to ligation of the artery alone, the veins alone (a considerable distance from the spleen), the arteries and veins and part of the arteries. The results were uniform at secondary operation: an atrophied organ was found massed in the omentum except where some of the arteries were ligated in which case these were areas of local atrophy in the body of the organ. The accompanying radiograph (Fig. 1) of a normal human spleen (postmortem) illustrates the distribution of the branches of the artery as it subdivides at the hylus. The result in all of our work on animals has apparently been atrophy rather than a rapid necrosis. The former might be secured in the human subject in a fairly small spleen, especially if enveloped in the omentum. The temperatures of the dogs were not observed nor was the blood pictures. Some of the dogs survived the secondary operation of removal of the atrophied organ and omental covering.

SUMMARY

The successful conclusion of the one human case and the experimental work on animals are not sufficient as yet to admit the operation as one to be recommended. To my knowledge the operation has never before or since been performed on the human subject. The operation will never supplant splenectomy. The latter, however, still has a very large mortality in the hands of most surgeons. Ligation of the artery may prove to be a safer procedure in selected cases.

My thanks are due Dr. J. R. Bolasny, Dr. Ira G. Downer and Dr. Frederick Neubauer for their assistance in the surgical laboratory; to Dr. Flinn F. Morse for his pathological work; and to W. K. Lim for the accompanying drawings.

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RETROPERITONEAL CYSTS OF WOLFFIAN ORIGIN

By J. M. MAURY, M.D., F.A.C.S., Memphis, Tennessee

MRS. A. R., age 28, white, married 7 years, entered Memphis General Hospital April 19, 1916.

Her family history and previous personal history have no bearing on the present condition as she is unaware of the presence of any tumors or growths in her antecedents.

Menstruation began at the age of 12 and has recurred regularly except during pregnancy and the puerperium. The periods recur every 28 to 30 days and last 4 days. Her last menstruation was April 12 to 15. She has had two children aged three and six years respectively, pregnancies and labors both being normal. For the past 18 months she has had frequent micturition, the bladder being emptied every hour or two both day and night. She came to the hospital on account of the presence of an enlargement of the abdomen which was first noticed in the left lower abdominal zone a little over a year ago. Since its appearance the mass has continued to increase in size.

Physical examination. The patient is healthy looking but rather thin. Examination of the thoracic organs, lymphatics, nervous, muscular and osseous systems and breasts reveals nothing abnormal. Several examinations of the urine revealed nothing abnormal except an occasional trace of albumin. Wassermann was negative. Blood normal. The abdomen is filled with a globular, fluctuating tumor reaching from the pubes to costal margins. There is central dullness and dullness over the left side of the tumor. There is a tympanitic note above and to the right side. In her first labor the perineum was torn into the rectum with resulting inability to control flatus and liquid stools. Cervix normal; uterus normal and anterior to the tumor which could be felt per vaginam.

The preoperative diagnosis was proliferous cyst, probably springing from the left ovary, with complete laceration of the perineum.

Operation April 26, 1916. The perineum was repaired after the method of Emmett. A median abdominal incision revealed the fact that both ovaries were normal and that the tumor had no attachments in the pelvis. Enlarging the incision and examining further showed a smooth, glistening, pearly, thin walled cyst having its origin posteriorly to the peritoneum in the gutter to the left of the spine. The whole lumbar gutter was filled with the cyst from up on the lateral abdominal wall to the spine, and from above the kidney to the level of the promontory of the sacrum. There was no semblance of a pedicle. The colon descended to its outer side. Enucleation was rapid and easy, care being taken to avoid the vessels going to the colon, and it was soon seen that the cyst had no connection with any organ. When enucleation was nearly complete the cyst was ruptured, discharging a clear, thin, watery fluid with a slightly amber tinge.

In the enucleation of the lower pole of the cyst a structure was encountered which was thought to be the ureter. Tracing it up, however, it was found to spread out and lose itself in the cyst wall and tracing it down showed that it did not go into the pelvis at the right place. Cutting this across revealed its structure to be tubular and a uterine sound put in the proximal end went into the cyst cavity. Dissecting out the distal portion showed it to go under the sigmoid and out into the broad ligament with, and a little below, the ovarian vessels; ending in the broad ligament about halfway between the uterus and the pelvic wall. There was left after removal of the tumor a large denuded area which was drained from behind and covered in front by suturing the peritoneum over it. Convalescence was normal the patient being discharged from the hospital in two weeks.

Pathological report. Macroscopically the specimens consist of a tube 25 centimeters long and a unilocular cyst whose capacity it is difficult to estimate but which would hold approximately 2000 cubic centimeters of fluid. The tube is 2 cm. in diameter, the wall being 1 cm. thick. Microscopically it is made up of fibrous tissue arranged in bundles and is lined with a single layer of columnar epithelium (Fig. 2).

The cyst wall is of variable thickness from very thin to 2 or 3 centimeters. Where an epithelial lining is present it is columnar or cuboid. The middle layer contains involuntary muscle fibers (Fig. 3).

Sections from different portions of the thick parts of the wall show the presence of the tubules (Fig. 4) and glomeruli (Fig. 5). The tubules are lined with cuboid epithelium (Fig. 6). One glomerulus (Fig. 7) is apparently well developed, the capsule and glomerulus being complete.

On looking up the subject of retroperitoneal cysts there is found a condition of considerable confusion. Those textbooks which contain any reference to them, and they are very few, dismiss the subject with the statement that retroperitoneal tumors do occur and may arise from kidneys, suprarenals, pancreas, and fœtal remains. The cases reported are mostly from foreign countries, only four being from this country. Etiologically, in addition to the organs noted above, they have been ascribed to misplaced ovaries (10), lymphatics (23) and the result of traumatism (21).

It is often impossible to determine the origin of these growths until a microscopical study has been made; because wolffian cysts, in their growth, may encompass or grow into, or be developed underneath the capsule (20) of the postperitoneal organs so that it may be necessary to remove the organ with the cyst.

From studying the literature one finds that the kidney, pancreas, and suprarenals may give rise to cysts with certain histological characteristics; but, otherwise, cysts arising postperitoneally are practically all basically the same histologically, yet show certain wide differences easily accounted for, as will be shown under the section headed pathology.

Thus in all we find the fibrous cyst wall lined with epithelium such as is found in the wolffian body, i.e., columnar, ciliated, or cubical; in many, canaliculi and glomeruli (24). One is also struck with the number the content of which is chocolate colored from admixture of blood elements, and while knowing this to be possible in any cyst it occurs so frequently in cysts in this locality as to attach to it a significance indicative to etiology.

In the case the report of which is herein published, a tube larger than a ureter, communicating directly with the cavity of the cyst, running downward, passing under the sigmoid and terminating in the region of the normal parovarium could certainly be nothing other than a wolffian remains i.e., the wolffian duct.

The only similar structure developed in this region, which might possibly exist as a fœtal remains, is the muellerian duct. From the muellerian duct, as is well known, is developed a fallopian tube, half of the uterus, and half of the vagina. As all of these organs were in a condition of normal development; which means the consumption or utilization of this structure; it could not have existed in its fœtal or undeveloped condition and location. In addition the demonstration of the presence of at least one complete and many incomplete glomeruli, and many tubules, in the tumor wall finally and completely settles the nature of this particular case. Therefore, one is forced to the conclusion that all postperitoneal cysts not arising from postperitoneal organs are genetically wolffian.

It is misleading, because inexact, to class all postperitoneal cysts under the name of retroperitoneal cysts and, as all cysts arising from organs should have a nomenclature in conjunction with that organ (i.e., pancreatic cyst, suprarenal cyst, etc.), would it not be better to reserve the name retroperitoneal cyst for those of wolffian origin or do away with the name altogether and call cysts of wolffian origin wolffian cysts?

Kroenig gives to Roth the distinction of first having pointed out the true etiology of these tumors, his article having been printed in Virchow's *Archives fuer pathologische anatomie*, 1881, lxxxvi, 371.

For a complete understanding of the character and location of these cysts, one must recall the development of the wolffian body in the lumbar region, the transformation and migration of its component parts, and the regression or atrophic changes to which it is subject.

As is well known, in man all of it is utilized, while in the female it exists almost entirely in an atrophic unutilized condition. As has been pointed out, this accounts for the greater frequency of occurrence of these growths in women, only two of the cases reported occurring in men.

WOLFFIAN BODY

The wolffian body or mesonephros is developed from a mass of mesodermic cells, the wolffian ridge, which joins the paraxial mesoderm with the lateral plate. From this mass of cells is formed the pronephric or wolffian duct which passes downward and

opens into the cloaca, into which also opens the primitive bladder and the primitive intestine.

While the duct is forming, the cells of the wolffian ridge, by a process of segmentation, are arranged into a series of solid columns or cords which lie transversely to the pronephric duct, each column being termed a nephrotome. Subsequently by a rearrangement of cells the nephrotomes become transformed from solid cords into tubules and open into the duct, which is thereafter called the mesonephric duct. The duct is fully developed by the seventh week of fœtal life and lies parallel to the primitive vertebral column and behind the parietal layer.

The free end of each tubule becomes invaginated by a capillary artery from the aorta, develops a Bowman's capsule, and forms a glomerulus. At this time the function of this organ is that of a kidney. This function in man, however, is but temporary and is taken over later by the permanent kidney. Retrogression of the glomeruli begins in the eighth week; the lower series of transverse tubules becoming atrophic, while the upper has to do with the formation of the sexual segment. From the lower end of the pronephric duct, by a process of budding, the ureter is formed, growing upward to the nephrogenetic tissue from which is formed the permanent kidney.

During the development of the wolffian body, the duct of Mueller, of uncertain origin, is formed, lying parallel with, and to the outer side of, the mesonephric duct. From the duct of Mueller is subsequently formed in the female the vagina, uterus, and fallopian tubes, while in the male it becomes atrophic. At about the same time the mesothelial cells undergo proliferation forming the genital ridge, from which is developed the indifferent sex gland. The indifferent sex gland becomes differentiated later into the testicle in the male or the ovary in the female. The undifferentiated sex gland lies in close relation with the upper or sexual series of transverse tubules of the wolffian body.

In the male the sexual series of transverse tubules forms the excretory ducts of the testicle, while the upper part of the mesonephric duct forms the body and tail of the epididymis and the lower portion becomes the vas deferans. The lower atrophic series of transverse series of tubules remains in the form of the paradidymus. In the female the wolffian body atrophies and remains as vestigial structures only. The upper series of tubules is represented by the hydatid of Morgagni; the middle series, with the adjacent portion of the mesonephric duct, by the parovarian or organ of Rosemueller; the lower series as the paraophoron and the unused portion of the duct as the duct of Gartner.

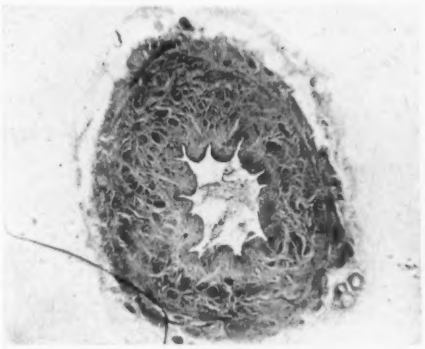

Fig. 1. Low magnification of transverse section of the duct showing arrangement of fibrous tissue bundles.

In the formation of the ovary, there is a thickening of the mesothelial cells on the peritoneal surface of the genital ridge and a proliferation of the primitive mesodermic or connective tissue underlying them. The mesothelial cells which form the germinal epithelium penetrate the mesodermic tissue in the form of cords and eventually form sexual cords or egg columns, from which are formed the graafian follicles. The medullary substance of the ovary is formed by the growth toward the egg columns of cord-like processes of the epithelial walls of the glomerule of the primitive kidney or wolffian body. These cells exist in the mature ovary as the interstitial cells distributed through the connective-tissue stroma of the ovary.

PATHOLOGY

In the description of the various specimens recorded in literature all of the component parts of the wolffian body — glomeruli, cili-

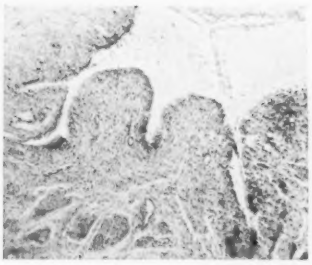

Fig. 2.

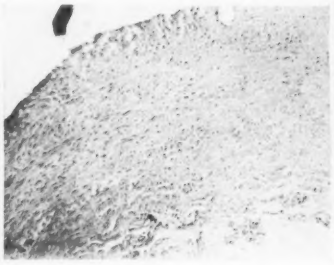

Fig. 3.

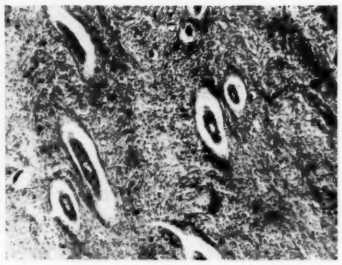

Fig. 4.

Fig. 2. High power of duct wall.
Fig. 3. Involuntary muscle in middle of layer of cyst wall.
Fig. 4. Sections of tubules seen in thick parts of the cyst wall.

ated epithelium, columnar or cuboidal epithelium, wolffian tubules and wolffian duct — have been found. Albarran demonstrated the presence of involuntary muscle fibers in the cyst wall.

The variety of findings, as shown by cases reported, is manifestly due to the neoplasm arising in one of the many portions of the wolffian body. A dilated duct simply shows columnar epithelium lining a fibrous wall and the presence of glomeruli and tubules is a chance condition the result of failure of these structures to atrophy.

It is maintained by Recklinghausen that ciliated epithelium is found only in the middle series of tubules, hence only in cer tain cysts will the ciliated epithelium be found.

In the case of Mauclaire (24), the middle zone of the cyst wall contained canaliculi representing uriniferous tubules and rudimentary glomeruli. Yet he distinctly asserts that the tumor was not part of the kidney and that that organ was not removed with the cyst.

Pathologically the tumors are found to exist in the form of (1) simple unilocular cysts, and (2) multilocular cystadenomata. The unilocular cysts are composed of a cell wall of fibrous tissue having an epithelial lining more or less complete. In Albarran's, and in my case, the presence of smooth muscle fibers are noted. Also in the cell wall has been found tubules of various sizes and shapes, varying with the angle at which they were cut, all lined with columnar epithelium. The epithelium lining the cysts has been described as flat, cubical, columnar and ciliated. The contents of the simple cysts is a watery fluid, clear or most often chocolate from admixture with blood elements, usually containing cholesterin. The simple cysts do not seem prone to malignant degeneration.

The multilocular cysts appear in two forms graphically described by Moore as: (1) "A primary cyst of considerable size with numerous smaller cysts embedded in its wall and projecting into its cavity. (2) The whole neoplasm may be made up of a mass of cysts varying in size but no one of which may be designated as the parent cyst" (17–20). Both varieties have a wall of dense fibrous tissue with an epithelial lining which may, however, show a papillomatous formation. The contents of the cavities is thick, viscid or jelly-like in consistency; opaque or chocolate colored; and in composition pseudomucinous or colloid. They are prone to malignant degeneration with the usual results. One case (Brown and Brady, 16) had two metastatic foci in the lung; and one in which the cyst had ruptured intraperitoneally (26) there was "the so-called peritoneal metastasis, with ascites, as is commonly seen in papillomatous cystadenomata of the ovary."

It has been seen that the epithelium lining the transverse tubules of the wolffian body takes on a higher development than the epithelium lining the duct, acting in a glandular capacity while temporarily functionating as a kidney. It has, therefore, been suggested that the simple cysts arise from the

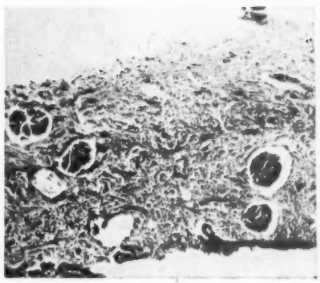

Fig. 5.

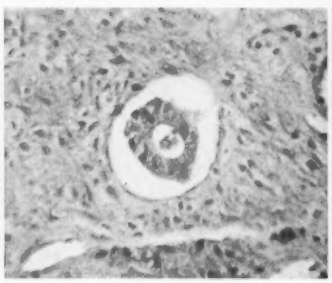

Fig. 6.

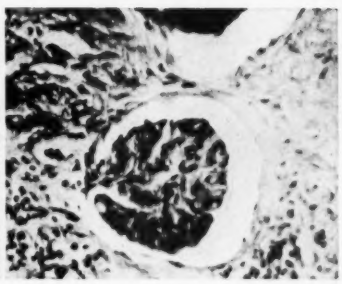

Fig. 7.

Fig. 5. A group of gomeruli in the cyst wall.
Fig. 6. Transverse section of a tubule with lining of cuboid epithelium.

Fig. 7. Showing completely developed capsule and glomerulus.

wolffian duct while the adenomatous tumors arise from the tubules. This is apparently substantiated in my case.

One curious thing which has been pointed out by Jacquot and Fairrisse is that these tumors although congenital do not show up until many years after birth, Albarran's being the only infant.

LOCATION

It has been seen that normally there are no wolffian remains left above the pelvic brim, but, from errors which may occur in development and migration, remains may persist in such location that in the event of subsequent development it may find itself between the layers of the mesentery, between the layers of the mesocolon, in the region of the kidney or even in the region of the cul-de-sac of Douglas (15) and later may occupy such positions as are determined by its primary location and the direction of its growth.

Jacquot and Fairrisse assert that certain remains of the wolffian body do not accompany the sex glands in their migration but remain at their primary place in lumbar and retroperitoneal positions. The colon may be to the outer or to the inner side of the tumor. The kidney, suprarenal, pancreas, and spleen may be slightly adherent or so attached that all or part of the organ must be removed with the cyst.

Agguere and Oliver found it necessary to remove the kidney. Mauclaire found the tumor adherent to kidney and suprarenal but easily separated therefrom. Because of their greater powers of proliferation and their tendency to malignant degeneration, the multilocular cysts are the most destructive in their growth. They form inseparable adhesions to parietal peritoneum and encompass and grow into juxtaposed organs.

SYMPTOMS

Most cases reporting for treatment came because of the presence of a tumor which, if large enough, produced the mechanical symptoms incidental to abdominal cystic neoplasms. In two cases jaundice had occurred though, as its etiological relationship to the tumor was not made clear, it was possibly coincidental. Also in one case several attacks of renal colic served as a misleading factor in making the diagnosis. In the advanced cases with malignant degeneration, there was the usual loss of weight and cachexia naturally to be expected from malignancy.

TREATMENT

The necessity for complete and early removal is evident. Aside from the unlimited growth, which is an inherent attribute, the tendency to malignant degeneration renders early removal imperative.

In one of the cases in which the kidney was removed with the tumor the description of the relation of the tumor to the kidney would lead one to infer that with a more accurate knowledge of the nature of the tumor the kidney might have been saved.

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PUERPERAL SEPTIC UTEROPELVIC THROMBOPHLEBITIS

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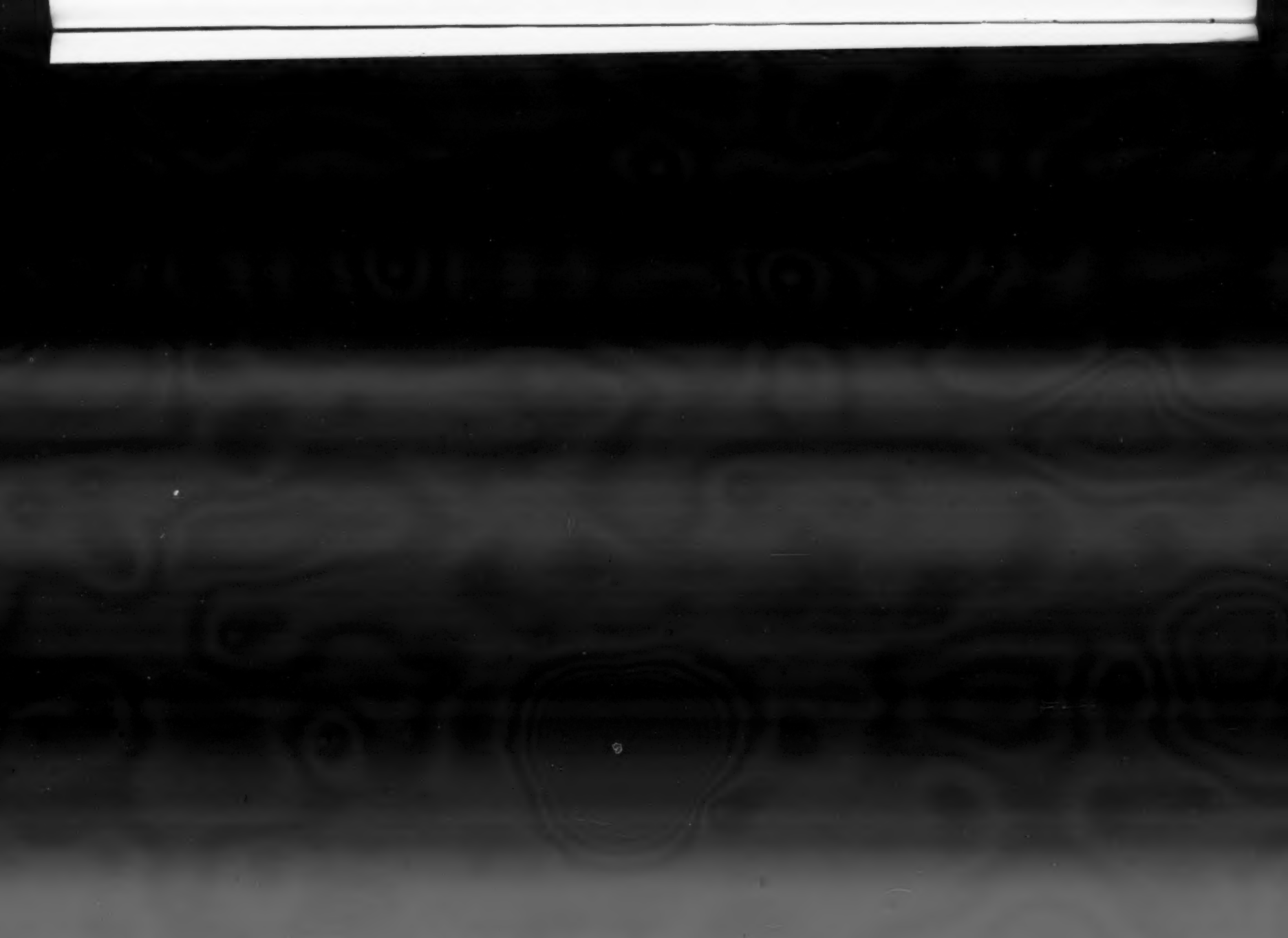
SOME few years ago Wallich at a session of the Obstetrical and Gynecological Society of Paris questioned whether there exists a distinct symptomatology of uteropelvic thrombophlebitis. If we judge by the silence of the majority of textbooks published in the last ten years, with the exception of a few American and German, it would seem that this grave infective complication of the puerperium, either remains to a great extent unknown or has disappeared from medical nosology. Yet it is a matter of considerable interest to describe the condition and the symptomatology which differentiates it, so that we may be enabled to formulate some direct and active treatment to arrest the invading process and prevent a fatal issue.

A retrospective glance at the medical literature of the latter third of the nineteenth and what has passed of the present century, shows that with the advent of asepsis and antisepsis an important modification has been produced in the clinical aspect of puerperal infections; certain forms, current from 1860 to 1870, have disappeared; others have persisted in attenuated form; others still have acquired a greater importance and can be better studied. To the first group belongs metroperitonitis always acute; to the second endometritis; and to the third *phlegmasia alba dolens*.

Thrombophlebitis has not escaped this evolution. Its anatomical pathology was known with exactitude particularly in its suppurative variety even in those early days.

It suffices to run through the pages of an old but admirably written book, Hervieux's *Treatise of Puerperal Diseases* (1870) to be convinced that the gynecologists of that date were well acquainted with the lesions of the uteropelvic thrombophlebitis; not only is the symptomatology of the affection proper very diffuse, but to this is added that which corresponds to various complications accom-



panying such a localization, particularly phlegmon of the ligament, peritonitis and septic pyæmia.

Recently there is again silence and a few lines only are devoted to it in the texts under chapters relating to puerperal infection.

It needed only the direct active struggle of the German gynecologists, Freund, Trendelenburg, and Bumm, against thrombophlebitis, to cause attention again to be focused on its modern symptomatology. In fact the operations proposed and carried out by these surgeons require a perfect diagnosis in order to justify venous ligature and such diagnosis must be sufficiently early in order that the desired results may follow the operation. At present the matter may be put thus: Does a precise symptomatology of uteropelvic thrombophlebitis exist? Is there an anatomopathological and clinical condition which justifies venous ligature? Do satisfactory results follow?

We give here the clinical history of a case which has suggested the considerations which will be referred to later:

Service of Maternal Protection, No. 1713–3675. Saturnina I. de A., 40 years old. VIII-para entered March 21, 1917; all pregnancies and labors normal; 2 twin pregnancies; menstruation regular since sixteenth year. Medical examination shows only a slight systolic murmur at the heart apex; numerous varices; urine shows no great diminution of chloride (234 ctg.) and 0.10 grs. of albumin, with nothing abnormal in microscopic examination.

On entrance it was found that she had been normally delivered March 10; but that the placenta was expelled after 5 hours under the action of some unknown drug. There appears to have been some slight hæmorrhage. About March 15 or 16 her left leg which during the pregnancy had caused her much pain, again became painful; the pain extended as far as the renal fossa on this side and was accompanied by a pronounced chill. Examination shows the left external saphenous enlarged and painful as also is the kidney region on the same side. Diagnosis of phlebitis is evident, and iodized-alcohol applications were ordered, with immobilization of the limb.

March 21 and 22, complete apyrexia. On the evening of the 23rd the temperature rose to 39.4° without a chill, falling to 37.5° the following morning. Renal and abdominal sensitiveness have completely disappeared. March 25. Temperature 37° in morning; at 3 p.m. chill lasting 15 minutes bringing the temperature to 41° and the pulse to 140 which on the previous days had oscillated between 86 and 120 according to the temperature. March 26. The general state is excellent; there only persists some pain in the left iliac fossa. Temperature 37.5° to 38.3°; pulse 100 to 108. March 27. Temperature 38.4° to 38.6°. Pulse 112 to 120; same findings March 28. Temperature 36.6° at 6 a.m.; at 10 a.m., chill lasting fifteen minutes; temperature 38.5°, pulse 112; at 3 p.m. new pronounced chill; temperature 40.4°, pulse 140°.

March 29. Temperature 39.3°; pulse 120 at 8 a.m. The patient was examined and the uterus was found mobile in anteversion and slightly in anteflexion; normal involution. No Hegar's sign; adnexa not palpable. In the thickness of both ligaments venous packets were clearly felt slightly sensitive and free in the cellular tissue; the lesion predominates to the left; there is no infiltration of parametrium. In the evening temperature 37.4°; pulse 104. Forty cubic centimeters of antistreptococcic serum was administered. Blood culture was negative. Temperature oscillated between 37° and 39° and pulse from 92 to 116, without chills. The general state was good. Locally the œdema of the left leg increased moderately. Immobilization and the iodine applications were continued. Ten milligrams of sublimate were administered daily intravenously.

April 4. Morning temperature was 36.6° and the pulse 96; but in the evening the fifth chill occurred, bringing temperature to 40° and pulse to 146. The general state seems depressed. April 5. Morning temperature 36.6°; pulse 92. In the evening of the 6th chill with 41° and pulse 156. A new examination on April 6th confirmed the signs observed March 29: bilateral juxta-uterine thrombophlebitis without peritoneal involvement. It was decided to operate and the patient was prepared accordingly.

April 7, operation. Operator, Doctor Turenne. Assistant, Dr. Colistro. Anæsthetist, Nurse Bruno. Morphine pre-operatively. Anæsthetic ethyl-chloride-ether. Extreme Trendelenburg position. Wide Pfannenstiel incision.

On opening the abdomen the peritoneum was found intact without adhesions or exudates of any kind. The uterus was more than double its normal empty size; it was reddish in color and without signs of perimetritis; it was slightly displaced to the right. The right adnexa were normal. In the thickness of the broad ligament on this side and about its base a thick cord was observed corresponding to the thrombosed uterine vein. Nothing abnormal was noted in the zone of the spermatic. The adnexa on the left were healthy; a vascular packet was seen to originate from the mesosalpinx occupying the cellular space of the broad ligament, fairly hard in consistency, in particular a vein as thick as a lead pencil, thrombosed and moniliform; the thromboses extended into the spermatic zone as far as the pelvic wall. No infiltration of the cellular tissue was observed and the edges of the broad ligament glided over the thrombosed veins.

Owing to the localization of the lesions I decided

to ligate the hypogastric vein on the right and the ovarian vein on the left.

About the level of the promontory and 3 centimeters to the right of the posterior median line, I made a vertical incision of 4 centimeters in the posterior peritoneum. The external lip of the incision was drawn outward exposing the ureter and the perivascular sheath. The vein clearly distinguishable from the artery was denuded and ligated about 1 centimeter beneath the bifurcation. Peritoneal suture.

The incision on the left was made 4 centimeters from the posterior median line; by separating the mesosigmoid toward the median line the vessels were found beneath. I proceeded in the same way as on the right side. For the spermatic I made the ligature near the pelvic wall. As the stitch passed through the thickness of the broad ligament there was a little bleeding and a fine drain was placed in the sinus formed by the ligament and the sigmoidal loop. Abdominal suture in three planes.

April 8. The condition of the patient is very satisfactory. An abscess of fixation is provoked as a prognostic measure. Temperature 36.2° to 38; pulse 92 to 104. April 9. The fixation abscess is positive. Temperature 37.2° to 37.8°; pulse 92 to 96.

After this the patient's condition rapidly improved. Between the 14th and 17th some alarm was caused owing to a sudden rise of temperature, and a very painful, multiple, peri-articular congestion appeared. However, as this coincided with the rapid development of the fixation abscess, this was incised on the 17th. Locally the venous packet on the right is found in the same state and that on the left enlarged but not painful.

After April 18 the fever disappeared and the signs of phlebitis of the lower left limb became less and less. Multiple blood cultures were negative and the pus of the fixation abscess was sterile.

From May 6 to 10 convalescence was interrupted only by an alimentary intoxication causing some slight fever which yielded to a purgative.

On May 12 examination showed the uterus in slight retroversion, mobile and painless. The right vascular packet was much reduced, however, a thin string could be perceived which represented a thrombosed small vein of the prevesical plexus. No vascular cord was noticed on the left and lack of elasticity of the broad ligament only persisted.

The patient was out of bed on May 10, and left the clinic completely cured early in June.

Before entering into the study of thrombophlebitis we may glance at the ideas concerning it currently accepted by gynecologists. However, these opinions are not sufficiently well known to the general practitioner and the opportunity of intervening efficaciously at the proper time is sometimes lost.

Unquestionably pregnancy and labor favor the development of venous lesions. Putting aside the aseptic thrombosis which accompanies the genital involution of the puerperium, there is a large group, varying from the simple varicose phlebitis of pregnancy to the severest postpuerperal infectious thrombophlebitis. During pregnancy we meet the same conditions as are found in experimental pathology which are necessary to provoke the venous lesion and its thrombotic consequences: modifications in the blood represented by increase in the number of platelets, particularly at the end of pregnancy and after the discharge of the secundines notable when these are concomitant with a poor general condition; acute anæmia; septic states; disturbances in the circulation after the modifications which the pregnancy imposes on the pelvic circulation, in veins which by their particular situation normally diminish the velocity of the current; penetration into the circulation during the whole cycle of the pregnancy of the numerous foreign substances originating for maternal defense against ovular poison, of all more or less transformed products of fœtal metabolism, of the toxines arising from defective functioning of the organs of elimination. If to these we add the impossibility of an ideal asepsis of the genital organs, the great frequency of an active microbian flora in the cervical and more especially in the vaginal lochiæ at a time when the puerperal lesions are in a state of repair, we find united in full proportion all the necessary and sufficient factors for a venous contamination of the genital zone.

Such considerations make us think that despite the silence of many classical texts puerperal thrombophlebitis is not a rare condition. Systematic and repeated examination of all puerperal infection cases has permitted us frequently to observe the physical signs of venous infection.

Pathologic anatomy as well as the clinic demonstrate that the venous lesion is a complication. Either the organism defends itself sufficiently and in a short time all is restored to order, or the parametrium, the adnexa, the peritoneum, and the veins of the lower limb become involved, and the thrombophlebitis passes to the second stage without

danger of giving place later to the clinical picture of pyæmia.

Owing to this combination and alteration the symptoms proper of thrombophlebitis may pass unperceived, and even with reason cause many to doubt its existence as a clinical entity.

Side by side with these complex cases are others more numerous which frequently pass unnoticed, because the focus of infection is discovered is taken care of without further trouble. Thus are left a reduced number of cases in which the venous lesion predominates and gives its special aspect to the evolution of the disease.

Thrombophlebitis is generally confounded with pyæmia with which it has many features in common, and in which it frequently terminates; but there is a period, long in some cases, in which the lesion is localized or progresses very slowly giving only occasional microbian or toxic signs, which the organism sometimes resists for weeks.

We ought therefore devote all our attention to the knowledge of this period since once passed we are powerless to combat with the generalized infection.

According to Michaelis, slight prephlebitic rises in temperature are of great value. I attach great importance to this sign, observing however, that the axillary temperature is extremely fallacious. But I think that a sign which I have never seen before described is of much greater value. Since 1906 I have observed that in that period which for convenience we will term "prephlebitic" (although adnexial phlebitis exists), there are early *rectal thermic increases* coincident with axillary apyrexia. This local hyperthermia which may accompany the initial pelvic process is a very early phenomenon since I have observed it four, five, and even eight days before the first axillary indication of fever. I think it is a sign much more valuable and constant than Mahler's pulse sign.

The early rectal increases have so much the greater value as hæmorrhages are frequently accompanied by peripheric hypothermia during the early days. But later when thrombophlebitis is established the curve is absolutely characteristic. From apyrexia or a subfebrile condition increases in temperature are observed at irregular intervals of one, two, even ten or more days, which reach at times 40.5°, 40.8°, 41° or even 41.5°. These accessions are not accompanied by either considerable or permanent changes in the pulse. If the pulse does rise to 140, 150, or 160 it is only during a chill and falls again with the temperature.

A sign worthy of mention is that other puerperal localizations, uterine, adnexial, parametrical, and especially septicæmia, are accompanied by a higher and a more permanently high pulse than thrombophlebitis.

The study of repeated blood cultures has given me interesting results. In thrombophlebitis I have found cases always or transitorily positive in the hours following chill. Outside of this the persistence of a positive blood culture is to me a sign of transition to septic pyæmia.

In forms purely localized I have found no serious uterine changes nor generally in the greater part of the organs and apparatus. I except the lung alone in which an embolus is not rare; I have never seen a fatal embolus due to pure septic thrombophlebitis.

Locally I think that the signs in simple cases are clear and precise and in this I disagree with Wallich's suggestion which was mentioned at the beginning of this article and the results of the discussion held in the Society of Obstetrics and Gynecology of Paris. In that type of thrombophlebitis which is called precocious I have generally found the uterus increased in volume, soft, mobile, and at times slightly painful. The adnexa are either not perceived or are normal. The signs may be reduced to a want of elasticity in the thickness of the broad ligament, a slight sensitiveness which contracts with the hyperalgesia of adnexitis or the adhesive matting of parametrial infiltation.

Generally the signs are very clear. At one time we can feel in the base of the broad ligament or in its thickness and following its upper border a hard moniliform string more clearly in the vicinity of the uterus than toward the pelvic wall. At another time the classical packet of varicocele, which is unmistakable, is palpable.

The precision of the contour of the thrombosed vessels allows differentiation of them from intraligamentary hæmatomata which systematic examination of normal puerperal cases has demonstrated to me are rare.

In some cases other thrombosed vessels can easily be perceived, especially in the prevesical space and in the thickness of the vaginal walls; with the exception of one case terminated by a retropubic phlebitic abscess all other cases thus located terminated by resolution.

That the patient remains in excellent general condition for some time is noteworthy; the appetite is good and sleep is not disturbed; a cheerful optimism possesses the patient and spreads to all who attend her. Many gynecologists have therefore remarked the surprise and incredulity with which the consulting physician receives their somber prognosis. In reality this apparent resistance which contrasts with the alarming rises in temperature is a characteristic of the clinical picture of thrombophlebitis in the localization period. It is only later on, when the general circulation swarms with streptococci or when multiple abscesses stud the viscera that the signs of rapid aggravation appear. Hence the clinical progress and the results of the physical examination give sufficient evidence to solve affirmatively the problem of the existence of pelvic thrombophlebitis.

If we are to judge by published statistics the prognosis is excessively grave; a mortality of 50 to 60 per cent is alarming. My impression, however, is that this mortality is exaggerated, and I am convinced of this because of the relative frequency in which signs of thrombophlebitis exist and still the cases terminate favorably. And not alone the precocious cases so terminate. My colleagues Drs. Infantozzi and Colistro in the Annual Meeting of the House of Maternity reported extremely grave cases ending with recovery. In the first of these the lesions were so extensive that the abdomen was opened in order to attempt venous ligature which was abandoned; the patient recovered and shortly after again became pregnant. But it is unquestionable that in cases where the febrile curve reaches the type described the mortality is high. All attempts made, local uterine treatment, vaccine, sera, sublimate and various colloids administered frequently intravenously have been failures, and the disease has advanced to some visceral localizations, thrombosed extensions of the inferior and superior cavæ or have terminated by septicopyæmia.

I have purposely omitted the fixation abscess from the methods of treatment. In fact Fochier's method, the efficacy of which is exaggerated by some and disputed by others, has not from the therapeutic point of view given us convincing results; however we have never employed it alone and the results must be placed to the credit of the general method of treatment of puerperal infections. But if its therapeutic value is discussible its prognostic value has become fixed in our service. In cases where there is a positive reaction a fatal evolution is so exceptional that in all grave cases we employ the subcutaneous injection of essence of turpentine as a method to learn early of the eventual progress.

In cases which appear contrary to experience a new provoked abscess generally negative or of very torpid evolution explains the apparent failure of the method. I remember only one contrary case: a woman in whom I amputated an enormous hypertrophied uterine cervix with prolapse at the end of the pregnancy and in whom a rapidly progressive gangrene demanded intervention. In this woman the abscess was positive. Even within the presence of co-existing articular and tendinous suppurative localization, the sign of a thrombophlebitis accompanied by early pyæmia; the case terminated by extensive thrombosis of the two *venæ cavæ*.

Because of the high mortality in such cases we were induced to operate in the case which we report, as the indications were sufficiently characteristic to warrant intervention and we hoped from the results to make deductions which might help to settle a question which up to the present time had not been definitely solved.

What should be considered a basis for surgical intervention? Experiments made in the past have shown the possibility of checking the septicophlebitic process by ligation at a

point sufficiently removed from the thrombus to insure against injury to the wall of the vein. A very recent article by MacLean (1915) proves that, no matter what is the condition of the ligated vessel, coagulum is always formed in the distal part of the vein. This author has shown also that the blood between the ligatures is rapidly absorbed leaving in its place a fibrous cord.

Otologic experience justifies ligature of the jugular in septic cases and it was this experience which in 1895 induced Freund to propose the ligature of thrombosed veins. Trendelenburg and Bumm performed this operation; but a sufficient number of cases has not been reported to date to render new data unnecessary.

K. I. Sanes, in an article read before the American Association of Obstetricians and Gynecologists, reported 122 cases published up to September, 1912, with 64 deaths, or 52.5 per cent, which is the percentage generally admitted. The same author makes note of 752 cases of thrombophlebitis not operated on with 395 deaths, or about 51.6 per cent.

Since then I have found in the available literature 17 new cases:

Authors	Cases	Recoveries	Deaths
Huggins.....	4	3	1
Brown.....	2	2	0
Jellet.....	5	3	2
Baldwin.....	4	3	1
Fromme.....	1	0	1
Turenne.....	1	1	0
	17	12	5

Percentage 29.4.

Fromme's fatal case, a primipara with post-abortive infection, was extremely grave and thus certain to failure. He found a complete thrombosis of the primary right iliac vein as far as the lower vena cava about 2 centimeters from the bifurcation; the left side was healthy. He ligated the vena cava 3 centimeters above the thrombus. The temperature fell for ten days, chills then set in and the patient died three weeks after operation. Autopsy showed that the thrombosis had invaded the iliac on the left side.

All authors do not favor intervention but judging by the cases published there is a notable improvement in the operative prognosis during recent years. Palmer Findley, analyzing 7 cases of varied evolution, is opposed to operation for the following reasons: (1) that the lesion cannot be demonstrated by laparotomy even if the fever curve is characteristic; (2) that if the lesions are situated very high nothing susceptible of ligature is met in the zone; (3) that infection may continue its invasion in spite of the ligature. Although his arguments are of some value in face of the very serious prognosis of thrombophlebitis, yet none of them is sufficient to lead us to therapeutic nihilism.

It is of interest to point out the contra-indications to intervention as it will serve to dissociate a series of cases which uselessly swell the statistics giving a false percentage of mortality, thus preventing some operators from using a therapeutic method which may benefit many patients.

In my opinion venous ligature is indicated —

1. In cases in which the septic venous lesion is directly diagnosed and there is no persistent bacteræmia between the chills.

2. When the genital and general clinical examination does not show any septic visceral foci which indicate generalization of the infection, utilizing from this purpose all present-day laboratory methods (leucocyte count, biopsy, roentgen diagnosis, etc.).

3. In cases in which direct examination gives doubtful results but where the clinical progress is characteristic.

Ligature is contra-indicated —

1. In cases of persistent bacteræmia or confirmed septicopyæmia.

2. When there are predominant uterine or juxta-uterine lesions (adnexial, parametrial, peritoneal). Doubtless in many cases while not proceeding to ligature or holding a doctrinal conservative position, laparotomy will afford a favorable solution of certain clinical and therapeutic problems.

This is the course of conduct which we advise should be followed until more extensive reports enable us to modify or ratify our ideas.

Technique. The most suitable method of procedure may be effected by three routes,

the extraperitoneal, the vaginal, or the transperitoneal.

The extraperitoneal route is used by Trendelenburg, Von Herff, and Lenhartz, is theoretically the least dangerous since it obviates peritoneal contamination. The following objections to this route may be made:

1. It permits only half of the pelvis to be approached for each incision.

2. Peritoneal protection is only relative if the thrombosed vessels are not easily accessible.

3. Owing to the difficulty of exploration it frequently happens that uninvolved vessels are ligated and those that are really thrombosed are not perceived. Moreover maneuvers are made exclusively under tactile control which explains why operators of repute have ligated a ureter mistaking it for a vein.

4. The incision does not allow easy and complete exploration of the juxta-uterine region which may show the necessity of complementary operations or contra-indicate venous ligature.

5. Finally this route probably for the reasons above has given the highest mortality.

Vaginal route. Without being opposed to the vaginal route I do not believe that it is ideal. It is evident that it reduces the traumatism to the minimum, and it cannot be denied that some of the pelvic veins can be ligated by it. However, I think that there are two capital objections: (1) it does not allow the ligature to be made at the required point when the thrombus, particularly if hypogastric, is situated near the iliac junction and less so if it is in the primary iliac or in the inferior cava; (2) the maneuvers necessary for inspection and venous ligature necessitate a manipulation incompatible with the justified fear of an easy fragmentation of the thrombus. Moreover, for the case in which it is desired to make a venous resection or an evacuation according to Baldwin's method, the peritoneal defense is greatly compromised. If to this is added the necessity of wide vulvovaginal approach, we see the reasons why the vaginal route is rejected as a method of choice. Besides, although the number of cases reported is few, yet with the exception of Taylor and Birmingham (3 cases with 3 recoveries), the mortality is high.

Transperitoneal route. For the surgeon accustomed to abdominal operations this is the surest and least objectionable method. There is little danger since habitual caution is observed and in case of meeting irreparable lesions the method permits closure of the abdomen without further inconvenience to the patient. The case of Infantozzi already quoted demonstrates its simplicity in the case of a patient whom he considered doomed.

This method is also rendered safe by adopting the extreme Trendelenburg position and the use of the Doyen and Faure retractors which give an ample field of inspection, and a clear sight of lesions appreciable to view and touch, permitting the intervention to proceed in the most rational manner.

The transperitoneal route alone facilitates high and complete ligatures, which, in pure cases like ours, are simply matters of operative technique. This technique which we have described in reporting the cases and which is that recommended by Quénu and Duval in 1898 for bilateral ligature of the hypogastric artery prior to rectal resection, obviates gross errors such as that of Leopold in confounding the vein with the artery or that of Lenhartz in ligating the ureter.

Having decided to approach the veins by the transperitoneal route, and assuming that the venous lesion has been found, in order to simplify the discussion, we may now proceed: (1) by ligature; (2) by resection; (3) or by venous evacuation, with or without hysterectomy and drainage.

1. *Ligature.* The majority of authors are content with ligature of the thrombus. It is the most harmless intervention and it has given the greatest number of recoveries. Doubt arises as to the height at which it should be made and the number of vessels which ought be included.

There is no doubt but that ligature of the inferior cava is dangerous; however, if we remember that the thrombus has already diminished its circulatory power we may suppose that the return circulation is already secured by collateral routes which normally have only a secondary importance. In the

rare cases in which it was done, the absence of disturbances of this kind permits our acceptance of this hypothesis.

Generally it suffices to make the ligature at the discharge point of the hypogastric without fearing, for the reasons stated, to execute it in the primary iliac. For the ovarian vein, ligature will be made where it issues from the broad ligament which is generally free.

Ligature of the thrombosed veins alone has given good results; but Fromme's case, in which after a favorable remission the patient died by invasion of a vein noted as healthy at operation forces us to reflect as to the value of ligating the four principal discharge trunks of the genital zone, the ovarian and the hypogastrics. In this respect it is well not to forget a venous return described and figured by Kownatzky in his fine atlas, *The Veins of the Pelvis*. I refer to the median iliac which at times discharges into the primary iliac or in the cava above the hypogastric and which as a carrier of the blood of the isthmic and superior regions of the uterus is capable of turning the germs of those infected regions into the general circulation.

Careful study of the atlas referred to moreover shows the extreme complication of the pelvic venous network during the gravid puerperal state, its irregular anastomoses and the necessity of high ligatures in order to prevent evacuation of the infected blood into the general circulation (Figs. 1, 2 and 3).

2. *Resection.* Resection is added to ligature in certain cases. The peritoneum undoubtedly is rendered liable to infection; but it is not impossible to proceed, as in case of suppurative adnexitis, by protecting the vicinity of the operative field and resecting with the galvanic or thermic cautery. Because of the good results of simple ligature — shorter and less traumatization — I think resection ought be reserved to cases of phlebitic abscess. Because of this, I am inclined to think that great probability exists of invasion of the general circulation by the streptococcus and the mortality following cases of resection bears out this presumption.

3. *Evacuation.* Baldwin, in the *American Journal of Obstetrics*, 1915, published a series of cases of thrombophlebitis treated as follows: Total transperitoneal hysterectomy, isolation and ligature of the arterial trunks, expression of the veins and evacuation of the coagulum, tamponade of the pelvis with iodoform gauze and wide vaginal drainage, suture of the sigmoid to the pelvic wall in order to isolate the large peritoneal cavity. In all cases the uterus contained abscesses of various dimensions. In 4 cases operated on he lost only 1 by late pulmonary embolus.

This series gives a favorable impression although the technique appears somewhat brutal; the frequency of uterine abscesses merits its being taken into account in the future. Up to now Baldwin is the only author who has followed this technique and a prudent reserve is the order.

In resuming we give our preference to venous ligature by the transperitoneal route. After the method of intervention has been decided upon, there is still one important point left which up to now has not been decided. A thrombophlebitis having been diagnosed, when ought we operate, and what elements ought we take into account when judging between expectant treatment which gives 50 per cent or more recoveries, or intervention which may give 30 per cent more?

The personal experience of individual authors is not at the present time sufficient to give clear indications; that the question is still obscure for many gynecologists can be verified by questioning men of large experience. If we add that in certain schools the puerperal vagina is a *noli me tangere*, it explains the many difficulties which a physician meets in endeavoring to formulate a firmly established rule of conduct.

The criterion of Bumm and other German authors who see the operative indication in the number of chills I consider to be unscientific. Neither the second nor the fifth chill should make us incline toward operation: (1) because it is not rare that patients with intermittent lochiametritis show repeated chills if the uterus is not methodically drained; and, (2) since it is not rare that patients recover after 10, 15 or more chills.

It is lamentable that at the present time we have not in the opsonic index and other analogous methods the means of judging the

degree of resistance to infection; the pyoculture of Delbet has not given any convincing results. We are forced then for the moment to be guided by careful clinical observations, using such further methods as are available to show if the patient is losing ground under the weight of the infection; and it is in such signs which are the only ones available that we find the indications to operate. Thus repeated blood cultures and finding the first invasion of streptococcus persisting for 24 hours add a great certainty in determining the moment of intervention. This determination is one of the matters which ought particularly be studied in the near future.

The extension which we have given to the operative phase of this subject ought not make us forget that though less brilliant, other conduct can give results more favorable than major operations. I refer to the prophylaxis of thrombophlebitis. A series of well observed facts permits of the disposition of this question.

Thrombophlebitis is observed only exceptionally in the rich classes and then I have seen it always follow criminal abortion by professionals, using septic instruments. Thrombophlebitis is generally the heritage of the poor, those who are badly nourished; exhausted; auto-intoxicated; those carrying for the greater part gonococcic cervical lesions, varicoses, and genital prolapses; those badly attended in their labors and in whom the uterine inertia of the secundines and its consequence, hæmorrhage, are frequent; those operated on late in the case of dystocia. With such patients it is no wonder that the statistics of thrombophlebitis are so great.

A retrospective glance shows us that in spite of this in the clinics to which these women come thrombophlebitis tends to diminish, since it reached its zenith between 1885 and 1905. To what is this due?

In that period when obstetrics entered into the zone of action of the Listerian method, prolonged and excessive repose was considered obligatory for the puerperal patient. But later as always happens the reaction led many gynecologists to the excessively early rising from childbed as proposed by the German School.

An appreciation of the facts has made us always partisans to early mobilization and getting the woman up. The brilliant results obtained by abdominal gymnastics in congestive pelvic processes have demonstrated early its use as a means of regulating the circulation. If we add to this that prolonged immobility tends toward disturbances of various organs, particularly intestinal inertia, a very important factor for microbic or toxic attack of the pelvic veins, it will be understood why in my private as well as my clinical practice when the hours immediately subsequent to labor have passed I allow liberty of movements, being guided as regards getting up by the progress of genital involution and the evolution of the puerperium. Intensive treatment of genital lesions and the rational treatment of gravid intoxications is based on the same prophylactic principle. With this object in view we have struggled in Uruguay and followed our objective so that the poor may be protected during pregnancy and meet labor strong and robust, vigorous physically and mentally with the knowledge that their condition has been zealously watched as an efficient factor for strong and healthy future generations.

The supervision of the secundines and puerperium ought be considered as important, not only because of the necessity of asepsis, but as a means of reducing to a minimum those physiological aseptic thrombi on which infections may be grafted.

We have purposely omitted from this article other types of thrombophlebitis which may be met in a gynecological practice. Although numerous points of contact exist between them and puerperal thrombophlebitis, yet they have their own modes of appearance, progress, and termination, the study of which is outside the scope of this article. Besides their history is so well known, especially that of postoperative thrombophlebitis, that interest in this study is at the present time much less than that of puerperal types.

CONCLUSIONS

1. There is a rational prophylaxis of puerperal septic thrombophlebitis.

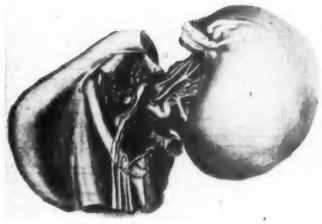


Fig. 1.

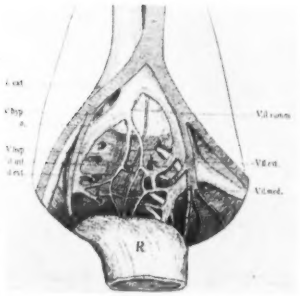


Fig. 2.

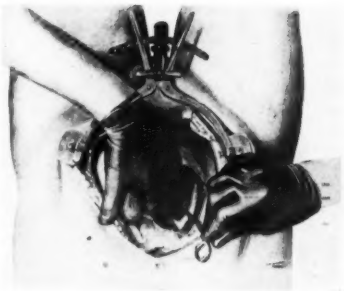


Fig. 3.

Fig. 1. The veins of the pelvis cut from above show the extreme complexity of the venous system as found in puerperium. This section represents the left part of the pelvis with the patient in the Trendelenburg position. It encloses the pelvic spaces of the virgin uterus; to the right, are the veins of the broad ligament injected and dissected. (*Kownatzky.*)

Fig. 2. Schematic drawing showing the field of operation. The vertical black lines indicate the peritoneal incision, the horizontal lines indicate the lines of ligature in the clinical case. (*Kownatzky.*)

Fig. 3. Ligation of the hypogastric and the median iliac. This figure represents the operative field with the patient in the Trendelenburg position. It is necessary to bear in mind that it is not necessary to make the peritoneal retraction as it appears in cut. (*Kownatzky.*)

Fig. 4. Chart showing the temperature curve.

2. Thrombophlebitis has signs, symptoms, and a clinical evolution which permit a diagnosis to be made in the majority of cases.

3. Although in more than half the cases there is a tendency toward subsidence and recovery, the high mortality justifies modern methods of treatment.

4. Surgical intervention, especially ligature of the thrombosed veins, is rational.

5. The transperitoneal route is the preferable one.

6. Ligation of all the efferent venous trunks of the genital zone is desirable.

7. Resection or evacuation of the thrombus should be resorted to only exceptionally.

8. The results obtained from direct intervention on the thrombosed veins should encourage new attempts at operations to fix definitely the field of operation.

9. Operations on the veins is contraindicated in cases of permanent bacteræmia, in accessible thromboses, and in cases of visceral pyæmic localizations.

DEPARTMENT OF TECHNIQUE

EXSTROPHY OF THE BLADDER

A Contribution to the Technique of the Extraperitoneal Operation

By C. C. COLEMAN, M.D., F.A.C.S., Richmond, Va., and R. J. WILKINSON, M.D., Huntington, W. Va.

THE principles controlling the successful treatment of complete exstrophy of the bladder include the familiar facts of general plastic surgery as well as the more obscure theories of the pathologic physiology of the upper urinary tract. Any method of treating this deformity by surgical means, therefore, must take into consideration not only the satisfactory mechanical disposition of the secretion from the kidneys, but also the protection of these organs from ascending infection. The recent developments in the surgical treatment of malignant tumors of the bladder and the radical removal of this organ in extensive malignant disease have given a new stimulus to the study of the effect upon the kidneys in cases of transplantation of the ureters with or without a portion of the bladder into some part of the large intestine. The technical difficulties of such transplantation have been largely overcome, but the problems relating to the subsequent health of the patients so treated are ones for serious consideration and can be properly solved only by careful study of patients after operation. Therefore all such cases should be reported so that definite conclusions may be drawn as to the best method of disposing of the secretions of the kidneys when the bladder is undeveloped, or is the seat of extensive malignant disease.

No descriptive reference is necessary to the many ingenious plastic procedures which have been proposed for the relief of complete exstrophy of the bladder. All attempts at the construction of a bladder from skin flaps have only added to the annoyance of this distressing deformity. An important advance in the surgery of this condition was made by Maydl in 1892 when he transplanted the base of the bladder into the sigmoid. This procedure, however, carried an almost prohibitive mortality from peritonitis.

Fig. 1. Photograph of exstrophy. Protruding posterior bladder wall and deformity of penis shown.

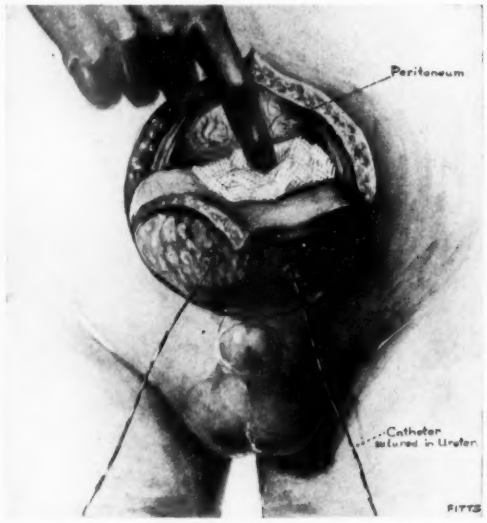


Fig. 2. Catheters fixed in ureters and primary steps of excision of bladder.

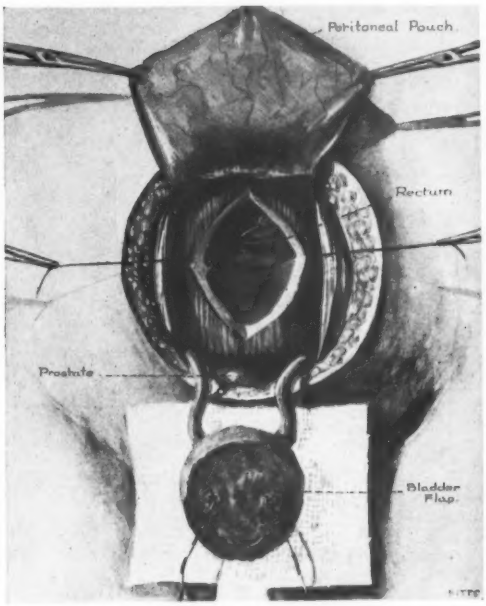


Fig. 3. Bladder flap completely detached. Incision in rectum spread by two tractor sutures. Peritoneal pouch removed from posterior surface of bladder in upper part of drawing.

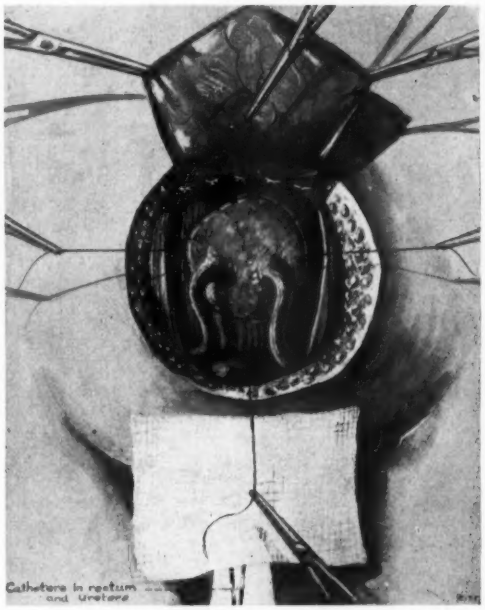


Fig. 4. Bladder flap rotated posteriorly and implanted into incision in rectum. Peritoneal pouch closed as high as possible with interrupted linen sutures. Ureteral catheters shown protruding from rectum.

In 1906 Moynihan transplanted the entire bladder remnant into the upper part of the rectum without opening the peritoneal cavity. This type of operation has met with considerable success in the hands of Moynihan, McGuire, and others, and was followed with slight modifications in the case herewith reported.

Preston C., male, age 16, referred by Dr. W. W. Vest, of Clarksville, Virginia, February 16, 1915.

The family history was unimportant. The child's health was very bad until he was 7 years of age but at this time he began to improve and apart from the bladder defect he became healthy and well-developed. The waddling gait characteristic of such cases was not well marked. He entered the hospital wearing a woman's dress on account of the irritation to the excoriated skin and mucous membrane caused by trousers. The defect was typical of complete exstrophy of the bladder (Fig. 1). The skin around the exstrophy was irritated by the constant flow of urine over the parts. A hernia was formed by the undeveloped bladder which protruded well beyond the plane of the anterior abdominal parietes. The right ureteral orifice was plainly visible, the left being somewhat hidden under an apparent overgrowth of mucous membrane. X-ray examination showed a separation of the pubic bones. The penis was dwarfed and furrowed along the dorsal surface. The anterior portion of the ureter was missing and the posterior portion was continuous with the mucous membrane of the exstrophy. There was some evidence of cutaneous epithelium growing to the bladder mucous membrane.

Physical examination showed a bright, healthy, well-developed boy with the exception of the complete exstrophy of the bladder. There were no associated developmental defects and no stones in the ureters. After careful treatment for a week during which time the patient was fed sterile food and the lower bowel irrigated by saline, he was operated upon after the method of Moynihan.

Operation, February 23, 1915. The sphincter ani was thoroughly dilated by an assistant and a ureteral catheter inserted into the ureters for about six inches and fastened to the papillæ with catgut sutures. With the patient in the Trendelenburg position, a median incision was made from a point 1½ inches above the upper edge of the exstrophy down to the mucocutaneous junction. The incision was then prolonged to the right and left through the junction of the bladder with the skin. The parietal peritoneum was first exposed under the median incision and peeled away from the bladder wall with dry gauze (Fig. 2). Free bleeding, particularly from the incision through the periphery of the bladder, accompanied this step of the operation. An accidental puncture of the peritoneum was immediately closed with linen. The pubic attachment of the bladder was not divided at this time, in order that better nutrition of the bladder flap might be preserved until the rectum was exposed for the implantation of the detached bladder. Further dissection exposed the ureters, which were elongated from traction of the

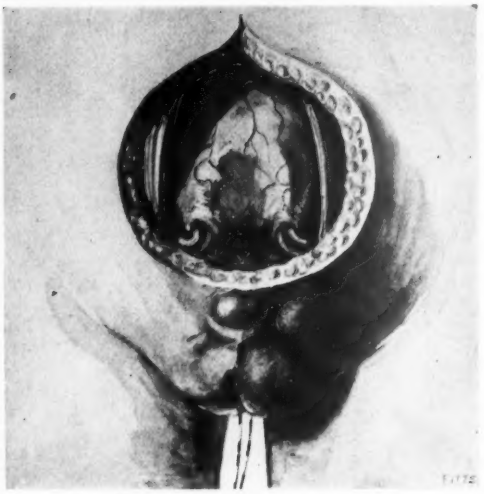


Fig. 5. Isolated pouch of peritoneum (Fig. 4) sutured over the anastomosis to give security to suture line. Operation complete. Cavity was packed with gauze, and defect partly closed later by plastic operation.

prolapsed bladder and occupied a position farther forward in the pelvis than in the normal case. They appeared to follow close to the brim of the pelvis nearly to the median ends of the separated pubic bone and from this point they entered the base of the bladder.

Care was taken not to injure the nerve and blood supply of the ureter by too close dissection. As soon as the ureters were exposed for a considerable distance, the peritoneum was pushed upward high enough to allow sufficient room for implantation of the base of the bladder into the rectum. An incision 2½ inches in length was made in the rectum beginning at a point 3 inches from the anus, and the edges of this incision were secured with catgut sutures, the ends of which were left long and used as tractors (Fig. 3). After cleansing the rectum carefully with bichloride sponges, the flap of bladder which had been separated at the pubic attachment, was trimmed to an oblong shape and rotated posteriorly into the incision in the rectum. There was an abundant blood supply to the bladder button through the ureteral arteries as shown by several small spurting vessels. The free ends of the ureteral catheters were passed into the incision in the rectum and brought out of the anus. The bladder flap was fixed into the incision in the rectum by four primary Lembert sutures of chromic catgut, and the anastomosis completed by continuous sutures of chromic catgut. There was no kinking or traction of the ureters. The redundant peritoneum, which had followed the bladder in its prolapse, was pulled downward and this pouch closed off from the general peritoneal cavity by interrupted sutures of linen (Fig. 4). The free end of the flap was then placed over the anastomosis and sutured carefully into position (Fig. 5). This use of a double peritoneal flap, to add security to the anastomosis, as well as to prevent a troublesome hernia, seems to be of considerable importance. The operation was concluded by packing the wound with gauze. After dilating the sphincter ani, a rubber tube was threaded over the ureteral catheters and secured in the rectum by strips of adhesive. The operation required 2 hours and 5 minutes. The patient left the table with pulse 120 and was considered to be in fair condition. For the first 6 hours he was quite ill. Both ureteral catheters were draining within 4 hours after the operation. The patient's pulse varied from 130 to 150 for the first 48 hours, although he seemed to be in reasonably good condition. Considerable difficulty was experienced in preventing the catheters from becoming plugged with mucus and it was necessary to remove the catheter from the left ureter on the third day; the right catheter, however, was allowed to remain until the fifth day. The catheters were of great assistance during the operation in facilitating the dissection of the ureters, but it is probably better to remove them at the completion of the operation, inasmuch as they serve no useful purpose after this time, are kept open with difficulty, and increase the tendency to ascending infection. The patient made a rapid recovery after the fourth day and had excellent control over the urine in 10 days. Three weeks later a plastic operation was done on the penis and the defect in the abdominal wall partly closed by sliding skin flaps. The patient was discharged from the hospital 6 weeks after the operation. On the night before his discharge he retained urine in the rectum for 10 hours.

The subsequent history of this patient is very interesting. Eight months after the operation he had gained 21 pounds in weight and was in excellent condition. There was no hernia, and he had indefinite control over the urine. His parents were instructed to awaken him once during the night to allow him to evacuate the rectum and he retained urine with absolute comfort for 3 or 4 hours during the day. On August 2, 1916, he was again admitted to the hospital with a large appendiceal abscess from which about 2 pints of pus were evacuated under gas oxygen anæsthesia. Six weeks later the appendix was removed and adhesions freed. He recovered promptly from this operation and left the hospital in about 3 weeks. In spite of the enormous strain thrown upon the kidneys by the long-continued abdominal suppuration to which were added two operations for the relief of this condition, there was no evidence of renal insufficiency. Probably no better clinical test could have been made to demonstrate the physiologic efficiency of any method of transplantation of the ureter into the intestine. The patient is now in perfect health, has no hernia, either at the site of the operation for the exstrophy or at that of the removal of the appendix, and the urinary condition is now as ideal as the changed anatomy will permit. He attends school and lives a normal social life. No positive statement can be made at this time as to the likelihood of an infection of the kidneys but the resistance of these organs during a severe illness in which there was a widespread sepsis argues well for their resistance to infection in the future.

The main points to be emphasized in the technique of the Moynihan extraperitoneal operation as they appear from observation of the case reported are as follows:

1. Careful protection of the ureteral blood and nerve supply. Experimental investigation has shown that impairment of the nerve supply of the ureter destroys its peristaltic action and converts it into a passive tube. Infection of the kidney readily follows.

2. Removal of the ureteral catheters immediately after operation. The catheter en-

ables a safer and more rapid dissection of the ureter but serve no useful postoperative purpose. They probably increase the tendency to infection of the kidney.

3. Prevention of postoperative hernia and reinforcement of anastomosis by utilizing the peritoneal pouch (Figs. 4 and 5).

The prolapsed bladder wall with the attached peritoneum constitutes a hernia. Interrupted sutures closing off this pouch from the general peritoneal cavity is analogous to the important procedure of high ligation of the sac in inguinal hernia. The distal portion of the double flap is used with great advantage to cover and strengthen the anastomosis between the bladder flap and rectum. Leakage of the anastomosis causes complete failure of the operation, for should the patient survive the infection the results will probably be an incurable urinary and fæcal fistula. There seems to be no mention in the literature of this use of the peritoneal pouch as described above.

4. Thorough dilatation of the sphincter ani to prevent rectal distention. This should be done before the operation is begun and repeated just before the patient leaves the table. Free exit must be provided for the escape of gas, urine and fæces until union of the anastomosis is firm.

TRANSPERITONEAL NEPHRECTOMY IN INFANTS FOR LARGE CONGENITAL HYDRONEPHROSIS

By M. S. KAKELS, M.D., F.A.C.S., New York
Surgeon to Lebanon Hospital; Visiting Surgeon Rockaway Beach Hospital

IN March, 1916, I reported a case of unusually large congenital hydronephrosis in an infant six weeks old. An anomalous congenital condition of the ureter was found to have obstructed the outflow of the urine. In view of the fact that recently I had occasion to operate on another case of stricture of the ureter in an infant ten months old I thought it might be of interest also to report this second case of transperitoneal nephrectomy for an hydro-ureteronephrosis, even if only as an illustration of another form of congenital obstruction of the outflow of urine from the kidney. In both cases the ureteral stricture gave rise to physical signs suggestive of an hydronephrosis, but only at operation was it clearly established that in one a congenital faulty insertion of the ureter at the ureteropelvic junction was the cause of the hydronephrosis, while in the other the hydronephrosis was the result of a congenital stricture of the ureter at its lower end, close to its vesical insertion.

The first case of hydronephrosis in the infant six weeks old of the type where the congenital occlusion was found at the ureteropelvic junction was published in the *New York Medical Journal* for March 18, 1916. A brief résumé of this report is given for comparison with the second case which will be described later.

Case 1. Male infant six weeks old was born ventricose. The abdomen kept gradually growing larger and larger until the child was brought to the hospital for operative relief. On palpating the abdomen fluctuation was elicited except to the extreme left where tympanitic resonance was obtained. In the right flank an elongated nodular mass was felt. There were no other physical signs. The infant except for the enormously large abdomen seemed in perfect health.

The X-ray examination corroborated the tentative diagnosis of a retroperitoneal fluctuating mass, connected with the kidney. The presence of a positive liquid thrill obtained by tapping the abdomen with the fingers together with the history from birth of a rapidly progressive swelling of fluid consistency pointed rather toward a non-malignant cystic tumor. We felt we were justified in making a diagnosis of congenital hydronephrosis, especially as this was confirmed by the X-ray plates, and therefore believed surgical interference was indicated.

At operation through an anterior abdominal incision an enormously large sac was emptied of about 900 cubic centimeters[1] of straw colored fluid, and it with the enlarged kidney was completely removed. The infant made an uninterrupted recovery after the transperitoneal nephrectomy and is perfectly well today.

At the time I presented the first case I mentioned the fact that not many cases of large congenital hydronephrosis in young infants have been recorded, owing to the rarity of the condition. About a year later I was fortunate enough to have the opportunity of successfully operating upon another infant ten months old for a similar condition and in a similar manner, namely, through an anterior abdominal incision.

In this case, however, the stricture causing the hydro-uteronephrosis was found not at the upper portion of the ureter but low down in the

[1] The normal capacity of the pelvis of the kidney in infants is 1 to 2 cubic centimeters.

Fig. 1. Case 1. Congenital hydronephrosis in an infant six weeks old. Stricture at the ureteropelvic junction.

urinary tract near the junction of the ureter and the bladder. A postoperative complication adds interest to the case and warrants a more detailed description.

CASE 2. The little infant Sarah F. not quite 10 months old was admitted to the pediatric service suffering from some disturbance of nutrition. It had been losing considerable weight and had been vomiting three or four times daily for some time. After this condition improved the child was transferred to the surgical service for the removal of a mass felt in the left hypochondriac region, which was movable, soft, and not tender. Otherwise nothing abnormal was found. The mass had been gradually increasing in size, was smooth and uniform, but no fluctuation could be elicited. There was no disturbance in urination. A diagnosis of retroperitoneal tumor was made by inflation of the colon. From observation and experience in the former and similar case above described, a congenital hydronephrosis was suspected.

On March 16, 1917, a left rectus incision was made through the anterior peritoneal layer and the peritoneum over the kidney incised. The large kidney with its large tortuous ureter dilated to the size of one's thumb coiled upon itself, looked like a loop of distended bowel. It was carefully dissected away from its retroperitoneal bed down

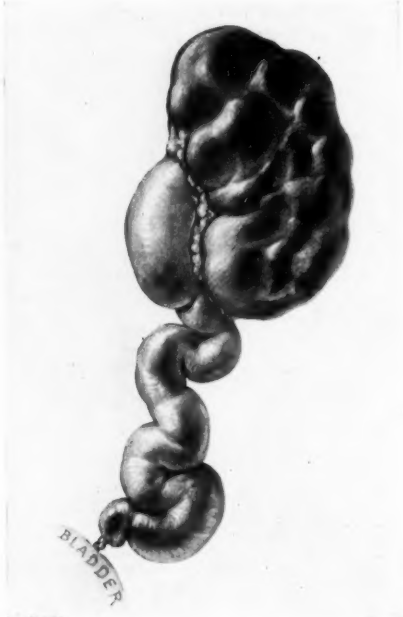


Fig. 2. Case 2. Congenital hydro-ureteronephrosis in an infant ten months old. Stricture near junction of the ureter and bladder.

to within a half inch of its insertion into the bladder, where a stricture was found. The ureter was uniformly dilated through its whole length and was more than seven inches long. The kidney was about the size of an adult fist, its cortex thin and soft.

On the sixth day after the operation the child developed symptoms of incomplete intestinal obstruction. Previous to this, a return of its digestive disturbance caused repeated vomiting. This repeated retching and vomiting had probably caused a separation of the peritoneal sutures. This was presumed because at reoperation a knuckle of bowel was found protruding through the peritoneum lying under the skin, whose sutures had held intact.

The bowel was replaced and the abdomen closed with through-and-through sutures. From this time on, the child made a complete and uninterrupted recovery.

To have recovered from two such formidable operations within one week speaks well for the vitality of infants and their resistance to such inroads on their economy.

Congenital urinephrosis arises principally from anomalies of the ureter due to developmental defects either at the upper, middle, or lower ends. These two cases well illustrate strictures, one at the upper and one at the lower end of the ureter.

To go into the different anatomical anomalies producing these strictures is beyond the scope of this paper. Suffice it to say although the clinical

diagnosis of large congenital hydronephrosis can readily be made in the presence of a large abdominal tumor, the etiological factor can only be ascertained at operation or autopsy.

The technique for removal of these large kidneys by transperitoneal incision is quite simple and requires little comment. The abdomen is opened through the rectus or by a pararectus incision. The intestines are held to one side by a large pack, thereby giving a good exposure. The posterior fold of the ascending or descending mesocolon is incised and through the rent the kidney is easily delivered from its bed and the ureter traced down to its insertion into the bladder. The vessels and ureter are doubly clamped and tied separately. After removal, the incision in the mesocolon is closed with continuous catgut sutures and the abdomen closed without a drain.

The present-day operation of nephrectomy is done through a lumbar incision. While this is wise in the majority of cases it seems to me in infants subject to large tumors of the kidney a transperitoneal incision through the anterior abdominal route offers better facilities, is more practical and advantageous on account of the better exposure gained thereby; besides it is safe, because strange to say infants bear laparotomies very well.

The general tendency has been to remove kidney tumors by the lumbar incision. This method is based upon the consideration of keeping clear of the peritoneal cavity. This no doubt is a weighty consideration. However, to remove these large growths through a lumbar incision in infants, especially where the costo-iliac space is so small, offers great difficulties and to me seems very hazardous indeed.

It has been my experience that infants withstand abdominal operations remarkably well. They stand handling of the bowels with few bad results, but they do not stand resection. This is well exemplified in laparotomies for intussusception, where in reduction of the intussusception a great deal of manipulation of the bowel is necessary. With careful asepsis peritonitis can almost always be prevented. A further advantage in the anterior route in young infants, is that the presence of another kidney is most assuredly ascertained.

SUMMARY

Taking into consideration the above statements and the experience gained from my cases, it seems to me the dangers of the transperitoneal route are inconsiderable in proportion to its advantages.

A NEW FRACTURE–ORTHOPEDIC OPERATING TABLE

By FRED H. ALBEE, M.D., Sc.D., F.A.C.S., New York

Major, M.R.C., U. S. A.; Professor and Director of Department of Orthopedic Surgery in New York Post-Graduate Medical School and Hospital.

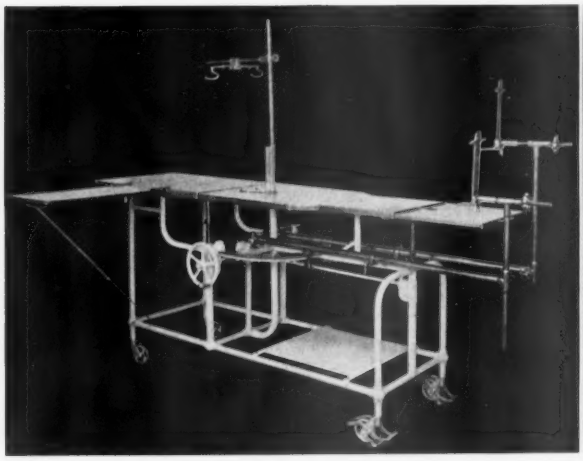
HISTORICAL

THE necessity for some external means of traction and leverage in the treatment of fractures and deformities of acquired and congenital origin is exemplified by the time-honored use of weights, screw devices, sand bags, pulleys, etc. More exact mechanical methods are of comparatively recent origin and appear to have been devised primarily as aids to the reduction of congenital dislocation of the hip.

Heusner (1), in 1897, described an extension table, but its use necessitated manual fixation of the pelvis. Schede (2), in 1898, devised a table which permitted extension in one plane, but, like Heusner's, it did not provide for fixation of the pelvis. In 1903, Heusner modified his original table, combining the traction feature of Schede's table with the addition of a trochanteric grip (resembling the *Hueftguerth* employed by Lange) as an ambulatory splint in unreduced dislocation of the hip. Ridlon, of Chicago, and Hibbs, of New York, have both devised tables which are a decided improvement upon those just mentioned.

Lemon (3) was probably the first to present to the profession an apparatus designed primarily for the production of extension. In 1907, Lemon described a fracture apparatus, the purpose of which was to enable the surgeon to reduce a fracture of any of the long bones of the lower extremity and hold the fractured ends in apposition while the plaster-of-Paris cast hardened. The apparatus was designed to be attached to an ordinary operating table.

The essential features of Lemon's apparatus



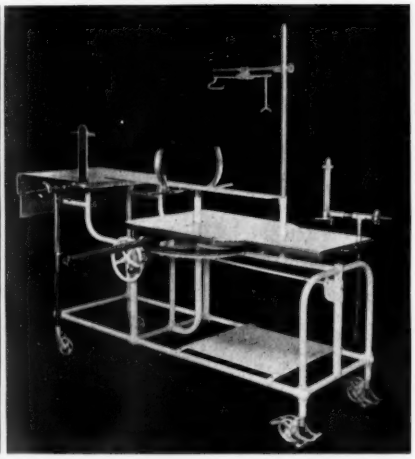


Fig. 1 (at left). Fracture-orthopedic operating table. Table opened to its full extent, showing the sliding leaf at the foot, hinged leaf at the head, the removable arm-shelf, with rest, the long traction rods with foot bars, the arm suspension apparatus, the perineal post, the swiveled rollers with locking apparatus, etc.

Fig. 2. The table prepared for securing traction in the position of neutral muscle-pull (anterior elevation of the arm) for controlling epiphyseal and surgical-neck fractures of the upper end of the humerus. The drop shelf at the head has been lowered, the shelf at the foot slid into the table top, the lower half of the table fully depressed, the arm suspension apparatus in place, the rest iron placed upon the hip rest post with the cross bar inserted and the axillary holds in position, and the thin metal board back rest placed on the iron. The leg traction arm in the foreground has been abducted to a right angle with the long axis of the table to secure traction and fixation if the arm is to be immobilized in the abducted lateral instead of the anterior elevated position.

were: (a) two long horizontal bars attached by their proximal ends to the main frame of the apparatus by friction discs permitting universal joint movement; (b) two uprights fixed to these horizontal rods to support on one side the sound knee and on the other the site of fracture, to prevent backward bowing; (c) foot rests on the ends of the long rods to which the feet were separately fastened; (d) a vertical post which served to fix the pubic arch and to support a plate upon which the sacrum should rest; (e) a vertical post with a shoulder rest; (f) extension of the legs was made by screws attached to hand wheels on the foot brackets.

Sanford and Fitzsimmons (4), in 1914, designed a table primarily to facilitate the reduction of congenital dislocations of the hip, but which could also be used in stretching operations and in fractures where traction is necessary for the approximation of the fragments.

Hawley (5), in April, 1913, presented before the New York Academy of Medicine a table "designed to provide for the suspension and immobilization of the lower extremities and trunk without moving or lifting the patient in any way, and to afford reliable support and traction of the lower limbs in the treatment of fractures." Hawley's table has a flat top in the center of which is a hip rest set practically flush with the center of the table. The top is made in two sections; a smaller one to support the head and chest, and a larger one, resting on four short legs, which act as levers, so that it can be lowered, leaving the smaller section and the hip rest projecting. Hanging downward from the foot of the table is a lever which automatically locks the top when it is up. The top is lowered and raised by a handle. The hip rest is fitted with two perineal posts, a short and a longer one with swinging arms from which a sling can be hung to support the knee or thigh and prevent sagging. To the side of the table frame are attached extension bars which can be placed at any degree of abduction (Lemon). On these bars are foot pieces to which the foot can be bandaged and traction applied. Much credit is due Lemon and Hawley for this table, many features of which have been copied in our table.

GENERAL CONSIDERATIONS

One of the largest problems of modern warfare is the treatment of infected compound fractures. These fractures are very unlike the compound fractures encountered in civil practice; the wounds

are extensive and infected, the bones shattered, and the problem is complicated by the presence of bullets, shell fragments or pieces of clothing. Plaster-of-Paris splints with extensive bridges or windows, applied in the ordinary limb postures, have been used in these cases in the past, but their employment as pure coaptation splints has now been largely abandoned because of the extensive complicating wounds and the necessity of wide exposure, thus interfering seriously with the control of the fragments which are being displaced by muscle-pull.

The fracture-orthopedic operating table finds its chief field of usefulness in accomplishing at the operating table that which the Balkan frame or other allied apparatus does at the bedside. With it the surgeon in the operating room can obtain the same degree of "position of neutral muscle pull," immobilization, fixation, and various mechanical postures which he can secure at the bedside by traction with the above mentioned apparatus. In this connection, reference should be made to the publications of Dr. Joseph Blake (6) on this subject.

In order to obtain the same results, it is necessary to employ a fracture-orthopedic table possessing a wide range of adaptability; i.e., all the various positions of neutral muscle-pull so essential to the successful treatment of fractures and readily attainable at the bedside by the above methods can be secured in the operating room only by a table which will not alone permit traction in any desired direction upon either the upper or the lower extremities but will also hold the affected part so fixed during the application of the plaster-of-Paris dressing that neither the traction nor the position of neutral muscle-pull on the one hand, nor the alignment of fragments on the other will be deranged.

Such requirements have not been fully and successfully met by any traction table yet on the market. The chief deficiencies of such tables have been: (1) Length and weight of table. (2) The difficulty in moving the table about, due to the absence of swivel trucks. (3) Projecting traction arms and other attachments, preventing use as a general operating table. (4) Limitations as to adjustments which would permit important positions of neutral muscle-pull and other indicated postures of the extremities. (5) The axis of the traction arm has always been placed at the center of the table, which is far internal to the axis of abduction-adduction of the hip-joint. This is a most serious objection; the axis of the traction should be made adjustable to variations of width of different pelves; in every instance the axis of the arm has been in the center of the table, far internal to the actual axis of the hip-joint, the result being that in attempting to abduct or adduct the limb, the amount of traction is never the same, for the axis of the limb is eccentric; under these conditions, the movement of the traction arm into further abduction markedly diminishes traction. (6) The lack of gradations in elevating or depressing the lower half of the table is a distinct deficiency; it has been necessary in all tables either to completely raise or lower this section. (7) Raising the depressed end of a fragment by former tables could be secured only by overhead methods which were an encumbrance to the operator.

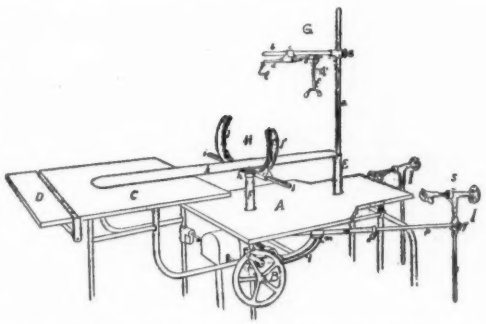


Fig. 3. The principal attachments of the fracture-orthopedic operating table are: *A*, Movable part of table top; *B*, wheel to raise and lower *A*; *C*, stationary part of table top; *D*, drop shelf; *E*, post forearm suspension apparatus; *F*, hip rest post; *G*, arm suspension apparatus: *a*, bar for vertical adjustment; *b*, suspension bar; *c*, carrier; *d* and *d'* sliding cross pieces adjustable to individual forearm; *e* and *e'*, hooks for traction bandages; *f*, hand rest for counter pressure; *g*, screw for fixing height of *b*, thus allowing for graduated traction; *H*, body holder for application of shoulder spica: *h*, rest iron; *i*, cross bar; *j*, *j'*, axillary holds; *k*, metal board back rest easily removable after application of shoulder spica; *I*, traction and abduction apparatus: *l*, grooved quadrant for control of abduction adduction of traction arm; *m*, set screw to hold traction arm; *n*, telescoping traction rod, recipient tube; *o*, set screw; *p*, distal half of traction rod; *q*, set screw; *r*, sliding rod for foot support which allows graduated adjustment of flexion and extension; *s*, screw for "fine" adjustment of traction (for details see Fig. 6).

Each of the above objections has been overcome by the writer in the *fracture-orthopedic operating table* which he has devised and which is herewith described:

GENERAL DESCRIPTION

The table is comparatively light in weight. Its top is constructed of Monell metal, which is non-corrosive and non-oxidizable. The frame is made of brazed tubular material, to afford the

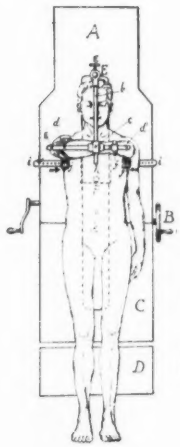


Fig. 4.

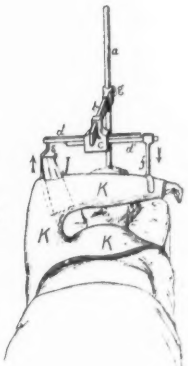


Fig. 5.

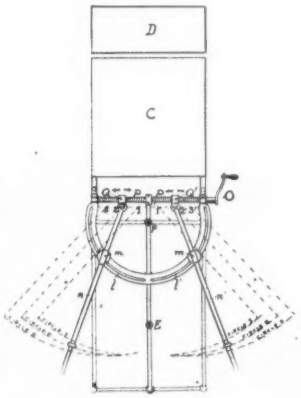


Fig. 6.

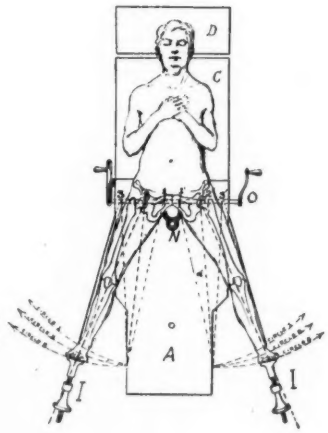


Fig. 7.

Fig. 4. Bird's-eye-view of patient fixed on the table in the position of neutral muscle-pull (anterior elevation of the arm) for controlling epiphyseal and surgical neck fractures of the upper end of the humerus. All the constituent parts of the arm suspension apparatus and the axillary holds can be dismounted and withdrawn from beneath plaster dressing, piece by piece, without disturbing the fixation. The axillary holds, *j* and *j'* are each furnished with an automatic catch which fits into holes in the cross bar, *i*, thus regulating the interspace between them. (The lettering in this figure corresponds with that of Fig. 3.) If these holds are pressed internally at their tips as shown by direction of arrows at *j*, they can be readily detached from cross bar.

Fig. 5. Method of using table to produce traction and to immobilize the arm by a plaster-of-Paris shoulder spica, *K*, in the anterior elevated position (neutral muscle pull) for epiphyseal and surgical neck fractures of the upper end of the humerus. With the wrist fixed by the hand rest, *f*, as a fulcrum, traction is maintained in the direction of the arrow by a bandage *J*, passed over the hook *e* of the cross piece *d* and beneath the proximal end of the forearm. Other letters as in Fig. 3.

Fig. 6. Screw adjustment of proximal ends of traction arms, a mechanical device for shifting the centers of rotation of the traction arms to points corresponding with or greater or less than, the interval between the hip-joints of the individual. The crank *O* turns the bar *P*, the halves of which have worm threads cut in opposite directions. Turning the crank moves the riders *Q* and *Q'* simultaneously, keeping them always equidistant from the center of the table. The pivots of the arms *n* and *n'* are thus made to travel along lines from *1* to *3* and *1'* to *3'* respectively, enabling the abduction or adduction of these arms to describe the arc of a new circle with each new position. The traction arms can be fixed upon the quadrant *l*, *l'* in any given position by the set screws *m*, *m'*. Other letters as in Fig. 3.

Fig. 7. Practical application of leg traction showing mechanism of the screw adjustment of the proximal ends of the traction arms illustrated in Fig. 6. Traction is made by the arms *I*, and *I'* against counter traction exerted by the perineal post *N*. The axis of rotation of the patient's leg in abduction has its center at *2*, *2'*, and the foot describes the arc of circle *2*. If the axis of rotation of the traction arm coincides with this, there is no change in the amount of traction from abducting or adducting the limb. If, however, the center of rotation of the traction arc is at *3*, *3'*, abduction causes the foot to describe the arm of circle 3 and the amount of traction is increased. If the center is at 1, 1' abduction causes the foot to describe the arc of circle 1, and there is great diminution in the amount of traction. (In former traction tables the axes of movement of the traction rods were rigidly fixed at points 1, 1'.

lightest and strongest structure possible. All four wheels are swiveled, the two at the foot end being furnished with foot-locks to fix the table and prevent it from rolling. When folded up, this table is as short as the usual general operating tables, and because of this and the fact that there are no parts projecting when it is not being used for traction, it is of use for general surgery and is particularly valuable in general military work. The traction tables heretofore in use have not been of practical use as general operating tables.

Details. The *trucks* of the table rest on swivel rollers, permitting it to be moved about easily, while a locking apparatus (Figs. 1 and 2) over the two at the lower end, operated by the foot, permits it to be easily fixed in the desired place. The ability to move the table about easily is of the greatest convenience, in that at any time during the operation the table can be so moved that better light is secured in the depth of the wound, or one's clinical observers can be afforded a better view of the operative procedure. The tables previously manufactured do not possess

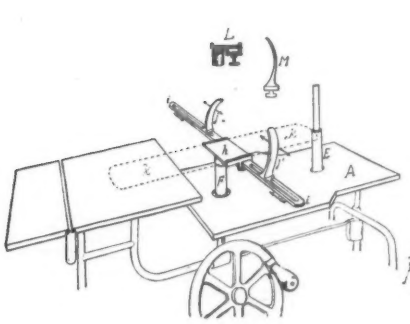


Fig. 8.

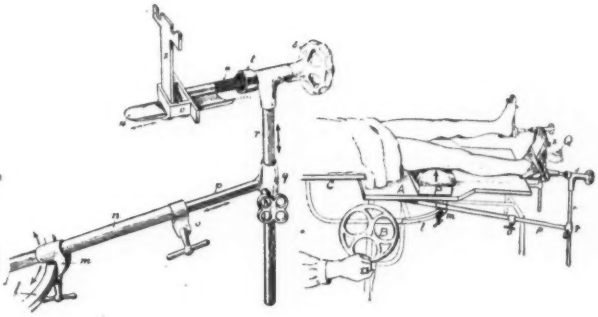


Fig. 9.

Fig. 10.

Fig. 8. Cross section of body holding device in detail. *L*, Cross section through *h*; *M*, profile of *j'*; other letters as in Fig. 3.

Fig. 9. Details of the distal portion of the traction arm and the foot hold. (*l*, *m*, *n*, *o*, *p*, *q*, and *r* as in Fig. 3.) *s*, Grip of screw for "fine" adjustment of traction; *t*, collar to prevent draping sheets from becoming "jammed" in threads of screw; *u*, adjusting screws; *v*, box for foot bar and heel rest; *w*, sliding heel rest which slides back to release foot and plaster splint from table; *x*, broad flat steel foot bar which after cutting bandages is withdrawn from slot in traction arm, thus freeing completely patient's foot from table.

Fig. 10. Practical application of traction. Position of body shown in Fig. 7. Foot bandaged by *Q* to the foot bar, the bandage passing over projection *x* of the foot bar. The leg is swung into the desired degree of abduction and fixed by turning set screw *m*. Gross traction is made by elongating *p* and fixed by tightening *o*. Flexion is secured by elongating *r* and fixed by tightening *q*. Greater traction is secured by turning grip of screw *s*. Lower half of table *A* is lowered by turning *B*. To overcome posterior displacement of a short lower fragment of the femur, a pillow or block and sandbag *P* may be placed under the offending fragment and the table again elevated, levering the fragment into place, while the internal fixation agent is applied whether it be an inlay bone graft, Kangaroo suture, wire, or Lane plate.

this locking apparatus and the wheels at the foot are not swiveled.

A sliding leaf (Fig. 1) at the foot, and a hinged leaf at the head allow the table to be lengthened as much as necessary, while a *removable shelf* (Fig. 1), steadied by a rest, can be used for instruments or to support the arm or leg of the patient.

The long traction arms, are telescoped, and therefore allow sufficient shortening so that they can be swung under and out of the way when the table is being used for general purposes and traction is not required.

Hip rests of two sizes are furnished.

The head of the table is movable up and down from the hip rest, similar to the Hawley table, so as to allow the application of various widths of spicas.

The foot end of the table is capable of being elevated or depressed to any desired height, by means of a wheel with handle, *B*. This *ability to raise or lower the foot-end* of the table by graduated adjustment is an important innovation, in that it allows sand bags or pillows to be placed beneath the sagging ends of fracture fragments, to elevate these fragments in the proper alignment, readily accomplished by a few turns of the wheel, the handle of which is accessible to the surgeon, by whom it may be grasped under a sterile towel, so that at any time during the operation the surgeon has the mechanism of the table under his complete control. If the surgeon is dealing with a hip case, he is enabled by depressing this portion of the table and inserting a sand bag under one buttock, to have complete control of the upward rotation of the patient's hip or pelvis in any degree desired, both before and during the operation.

Lengthening of the traction arm is accomplished by two adjustments. Coarse adjustment is attained by graduated telescoping of the arm; and a more powerful, fine, adjustment, accomplished by means of a screw. This screw differs from those of previously constructed tables in two respects: First, it feeds as well distally as proximally when the wheel is turned. Failure of this back-feed has proved a great annoyance in other traction tables which the writer has used. Second, the screw threads are covered by a metal cuff which prevents jamming of sheets or towels into the threads while traction is being made.

The foot is held in position by a muslin bandage placed over it and including in its folds the movable *flat bar*, placed against the plantar surface of the foot and the curved plate beneath the heel. These flat bars (foot-plates) are very

strong, being made of solid steel; in certain other traction tables the foot-plate bends. These plates fit into the distal extremities of the traction rods, at which point *the small sliding curved plate* prevents compression of the heel and obviates dropping down of the foot due to the obliquity of its dorsal aspect where the bandages encircle it during the application of a large amount of traction. This sliding plate prevents the foot from skidding downward away from the foot piece, an accident which commonly occurs with certain other traction tables. After plaster-of-Paris dressings have been applied, and the restraining muslin bandages cut, both of these sliding plates are removed, thus freeing the patient's limb from the traction arm without disturbing the plaster.

Screw-adjustment of pelvic ends of traction arms (see Figs. 1; 6, O). The proximal ends of the traction arms are universally adjustable by means of a heavy screw placed crossways to the table. This screw bar is placed (to correspond with the horizontal plane of the hip-joints) slightly above the perineal post (the horizontal plane of the symphysis pubis). The distance apart of the perineal post and the screw bar of the traction arms represents an average of comparative measurements of various pelves.

The direction of the threads of this screw bar are reversed on the opposite sides of the center, so that when the attached crank is turned the ends of the traction bar uniformly converge upon or diverge from the center, of the table. This enables the surgeon to make his adjustments in accordance with the width of pelvis of each individual case, so that traction remains constant throughout abduction or adduction, which is usually desired. However, by placing the axes of the traction arms farther apart, the amount of traction may be increased as abduction is increased; the opposite result is secured when the axes are placed nearer the center. In the management of dislocations and fractures near the hip the former may be an important and valuable adjustment.

Counter traction is supplied, as in most other tables, by means of a *perineal traction post.*

Traction on the upper extremity. In the year 1908 the writer (7) first described the anterior elevated position as the position of neutral muscle-pull for controlling epiphyseal and surgical-neck fractures of the upper end of the humerus. No operative fracture-table has heretofore been devised which enables this position and traction to be maintained both during the operation and the application of the plaster-of-Paris spica. This is an important feature of the table herein described. With the foot-end of the table fully depressed, a rest-iron, Fig. 3, *h*, is placed upon the hip-rest post, with the cross-bar inserted. The thin metal board back-rest, *k*, is placed on this iron and the head portion of the table. The patient is then placed with back and occiput resting on this board, with the shoulders in the region of the cross-bar. The post, with arm-suspension apparatus, *G*, is put in the post at the foot-end of the table, with the arm-traction bar properly adjusted to the individual case, the elbow flexed to a right angle and the wrist placed beneath the hand-rest, *f*. Traction is then applied to the humerus by means of gauze or muslin bandages passed beneath the upper end of the forearm near the elbow-joint, and over the hook, *e*, in the cross-bar of the arm-suspension apparatus above. The axillary holds, *j*, are then placed on the cross-bar, *i*, and adjusted in place. For counter-traction, the weight of the patient is usually sufficient; if not, it can always be adequately secured, afforded by bandaging the shoulders to the cross-bar which carries the axillary holds. The patient is thus firmly held with traction in the ideal position of neutral muscle pull, not only during operative fixation of the fracture fragments but the position and the traction remain undisturbed during the application of the plaster spica, precisely as in the application of the hip spica.

To release the patient from the table after the application of the shoulder spica, it is necessary only to cut the bandages external to the plaster, disengage the wrist rest, pull out the cross bar and axillary holds, elevate the patient's shoulders, and remove the back rest board. If it is desirable to fix the arm in the abducted lateral position, traction and fixation may be secured by abducting the leg traction arms to a right angle with the long axis of the table and applying traction by straps above the wrists in precisely the same manner as in traction upon the lower extremity. In the case of fracture of the forearm or in the region of the elbow, adhesive stickers may be applied to the point of fracture, left in place and covered by the plaster dressing, or a carefully applied wristlet may be employed.

USES

1. It may be used for the reduction by the closed or open method of fracture of the extremities, particularly about the hip or upper third of the femur. The maintenance of traction and the limb posture (as neutral muscle pull) during the application of the fixation dressing, viz., the anterior elevated position of the upper arm in the

case of fracture of the upper end of the humerus (position of neutral muscle-pull) or the abduction-flexion position (neutral muscle-pull) of the thigh in fractures just below the lesser trochanter. Many other such mechanical postures could be enumerated but lack of space forbids.

The table is of great use in the mechanical fixation position of abduction (Whitman) in fractures of the femoral neck.

During traction, lateral displacement of fragments can be corrected by direct pressure. The rough edges and serrations in oblique or transverse fresh fractures can be utilized under the influence of traction to interlock the fragments and maintain reduction.

The importance of full surgical anæsthesia is inestimable in the case of all fractures, in order to obtain complete muscular relaxation.

2. In compound comminuted gunshot fractures, where the necessity of limb posture is doubly indicated on account of the inability to make the most of co-aptation splints because of the loss of large amounts of soft tissue.

3. The reduction of dislocations (traumatic or congenital) and the maintenance of limb posture during the application of fixation dressings.

4. The application of plaster-of-Paris fixation dressings in the treatment of joint diseases, etc.

5. Joint resection, osteotomy, osteoplasty, etc.

6. Application of plaster-of-Paris jackets.

In closing, it may be remarked that many of the latest books on fractures make no mention of traction operating tables or the advantages of them. In other words, an indispensable general method of fracture control is entirely overlooked by those most competent to advocate its use.

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RUBBER TUBE RECONSTRUCTION OF THE COMMON BILE-DUCT

Sullivan's Method[1]

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THE various problems of bile-duct reconstruction and repair have been discussed in several recent papers. Study of the question has been much stimulated since Jacobson's excellent article of three years ago in which he collected more than 30 operated cases. Brewer, Mann and Sullivan, together with a few foreign surgeons, had then performed a total of 22 reconstructions by the rubber tube method which Sullivan experimentally devised. Variations and improvements have been offered, the most valuable being the use of the T-tube as employed by Mayo and the Walton operation with its modification suggested by Ginsburg and Speese. Lengthy discussion of the subject or its literature is scarcely justifiable at this time, but we deem the following case as worthy of a detailed report:

Mrs. A. R., age 38, housewife, was admitted to the St. Louis City Hospital on October 6, 1915. The patient was the mother of six healthy children, and except for an appendectomy seven years before and two induced abortions in early married life, she gave no history of past illnesses. The illness for which the patient sought relief began acutely ten days before her admission, being ushered in with colic-like pains in the gall-bladder area, radiating at times to the back and the right shoulder. The patient had vomited much during the first three days of her illness and had suffered excruciating pain during the frequent recurrences of the attacks. Jaundice was noticed by the patient five days after the onset of the illness, which time marked the cessation of the colic. She complained upon admission of "soreness" in her upper abdomen and distress upon taking food.

Examination revealed a poorly nourished white woman of medium stature. The mucous surfaces were pale, skin and scleræ markedly icteric; the tongue heavily coated, breath foul. Chest examination was negative. The abdomen was generally slightly rigid, with marked tenderness

[1] From the St. Louis City Hospital, surgical service of Dr. M. G. Seelig.

in the epigastrium and particularly in the gall-bladder area. Temperature 100.6°; pulse 100. The leucocytes were estimated at 10,200. The urine gave a positive test for bile. The stools were not acholic. X-ray examination for gall-stones was negative. Under expectant treatment the jaundice rapidly disappeared, and the temperature and pulse remained normal. The patient complained bitterly, however, of "soreness" in the gall-bladder region and of severe epigastric pain upon eating. Operation was advised to which patient agreed.

Operation. October 18, 1915. The peritoneal cavity was opened through a high vertical incision slightly to the right of the midline. The omentum, stomach and duodenum were found densely adherent to the under surface of the liver, completely obscuring the gall-bladder. In separating the adhesions, the liver capsule gave way, resulting in an obstinate capillary hæmorrhage. Dissection was very difficult, because of the number and density of the adhesions, but the gall-bladder and the bile-ducts were finally identified. No stones were present either in the gall-bladder or the bile-ducts. Cholecystectomy was decided upon because of the highly diseased condition of the gall-bladder, and this was done by freeing the fundus first and continuing the dissection downward. In separating the densely adherent lower portion of the gall-bladder from the duodenum, it was found that a large communication existed between the two, and that separation left a large opening in both duodenum and gall-bladder. After cholecystectomy had been accomplished, a longitudinal rent 1 centimeter in length was found in the anterior wall of the common duct at a point immediately above its duodenal outlet. Through this rent a flexible probe was passed upward into both hepatic ducts and also downward through the papilla into the duodenum. Repair of the duodenum was rendered very difficult by the fragility of its inflamed wall. The lumen was very much narrowed by the double row of sutures, and on this account, as well as through fear that the sutures might give way, a gastro-enterostomy was hastily performed with a large Murphy button. A small rubber tube was inserted upward through the rent in the common duct and secured with a catgut stitch. The wound was closed in layers after providing for drainage by means of two large cigarette drains.

Operative injury to the bile-ducts has been reported with sufficient frequency to disillusion those who regard cholecystectomy as a simple operation. We are of the opinion that such injury is frequently unrecognized, and that it is reported much less frequently than recognized. The injury occurred in this instance at the hands of a skillful and careful operator who sought to minimize danger of injury to the common duct by freeing the gall-bladder from the tip downward instead of proceeding upward from the duct. The injury was, however, not extensive; and had it not occurred, the duct should have been incised. We consider incision and exploration of the common duct necessary in such cases in order to establish the freedom of the bile passages from stricture or stone. Drainage of the common duct for a few days is likewise desirable. It is to be emphasized that *the operative injury in this case did not produce loss in continuity of the common duct.*

The spontaneous cholecystenterostomy which necessitated repair of the duodenum after the gall-bladder had been removed was to be viewed as a much more serious complication, for the condition was analogous to that produced in transduodenal operations which are not infrequently necessary, and in which the fear of duodenal leakage always arises. The gastro-enterostomy we now believe to have been a life-saving procedure and one to be more frequently made use of in duodenal repair incident to transduodenal operation or duodenal injury.

The postoperative course was as follows:

Vigorous hypodermic stimulation was necessary during the first few hours. Recovery from anæsthesia was slow, and the general condition was precarious for several days. Beginning immediately after the operation the discharge of bile both through the tube and into the dressings was very profuse. The wound became infected and exuded much pus. On the fourth postoperative day, a duodenal fistula manifested itself, setting up much wound digestion and skin excoriation. At this juncture drainage of bile through the tube ceased, the total biliary secretion together with duodenal contents being discharged alongside the tube into the dressings. No trace of bile appeared in the stool. The tube was withdrawn from the common duct on the sixth day, as the stitch holding it loosened and permitted withdrawal. The other drains remained in place. The patient was nourished by means of glucose solution per rectum, supplemented by nutrient enemata, only small quantities of fluids being administered by mouth. Remarkable to relate, the duodenal fistula spontaneously ceased discharging on the ninth day, and the wound, after extruding much necrotic tissue, began to heal. Convalescence from this point was more satisfactory, permitting removal of the drains on the fifteenth day. The patient sat out of bed on the thirty-sixth day and the Murphy button was recovered from the stool on the thirty-ninth day. Though weak and emaciated, the patient was free from discomfort. After the operation not the slightest trace of bile ever appeared in the stools, while heavy dressings were saturated twice daily with greenish-yellow to bright yellow bile.

The development of the duodenal fistula occasioned much alarm, for unless repaired by a second operation this complication terminates quite regularly in death. The extremely grave condition of the patient deterred us from operative interference, and for a time no hopes were entertained for her recovery. The spontaneous healing was in our experience altogether unique. It was possible we believe only because there was complete diversion of the bile from the duodenum through drainage of the common duct, and diversion of stomach contents through gastro-enterostomy. The complete permanent biliary fistula we considered to result from obstruction (most likely by adhesions) of the common duct below the opening through which the drain had been inserted. In this premise we were proved mistaken by the second operation.

Operation. January 13, 1916, by the author. Incision was made slightly median to the old scar and fistulous opening. Numerous adhesions between omentum, stomach, liver and duodenum were divided by careful, blunt dissection. The biliary fistula was found to result from a complete loss in continuity of the common duct, the defect being about 2 centimeters long, involving that portion immediately above the duodenum. The stump of the duct above the gap was firmly imbedded in dense adhesions, but the lumen was of normal size and a probe was easily passed upward into both hepatic ducts. Clear bile flowed slowly during the operation. A lower stump or remnant communicating with the duodenum could not be identified. The duodenum was firmly fixed by adhesions, the wall was thickened and friable, the lumen very small. The pyloric end of the stomach was likewise fixed by adhesions and contracted. The gastro-enterostomy opening was patent. A hasty consideration of operative possibilities led to the following procedure:

A piece of fairly stiff rubber catheter, size 17 F. about 7 inches long was used as a tube. One end of this was passed upward into the lumen of the hepatic duct as far as the bifurcation and fixed in place with chromic catgut sutures. An opening was then made in the duodenum, just sufficiently large to permit of passing the remainder of the tube (about 4½ inches) into the lumen. The tube was anchored to the edges of the opening with chromic catgut sutures, but no attempt was made at valve formation by inversion sutures because the friable duodenal wall did not hold the sutures well. An artificial duct was then constructed by enclosing the 2 centimeters of exposed tube with omentum, utilizing also adventitious tissue which had made up adhesions. This omental "casing" was stitched above to the hepatic duct and below to the duodenum. Two rubber dam drains were inserted and the wound was closed in layers. The patient was in fair condition at the close of the operation.

This second operation showed a complete absence of at least 2 centimeters of the bile-duct which certainly was not removed at the first operation. The loss was undoubtedly due to a necrosis provoked by one or a combination of the following factors: (1) operative trauma; (2) pressure (from drain); (3) infection; (4) digestive action of duodenal secretion.

The last two we consider to be of most importance. The abdominal wound showed much necrosis, due to infection and the irritation of the duodenal fluid. The first two factors could be excluded in the case of the abdominal wound; and our presumption is that the necrosis in the depths was quite analogous and produced by the same causes. Brewer felt that infection and digestion were responsible for sloughing and loss in continuity of the common duct in one of his cases. The question arises here as to whether the duodenal leakage might not have occurred from the site of opening of the necrotic common duct instead of along the suture line.

The method of reconstruction was adopted according to the exigencies of the case. On account of the firm fixation of the duct and duodenum, a direct implantation of the duct stump into the duodenum or jejunum was impossible. The condition of the duodenal wall prevented employment of Walton's operation, or its modification, a circumstance which may frequently occur in this type of secondary operation. The various plastic operations, such as fascial transplantation, the use of gall-bladder, appendix, etc., were all unadapted because of the condition of the duodenum and duct. Furthermore, the appendix and gall-bladder were both absent in this case. The choice between the use of the Mayo T-tube and the operation of Sullivan was not so lightly determined. It seemed to us a definite advantage to use a method which would restore the duct in its entirety, and not again leave a defect when the T-tube was removed. A further disadvantage in the use of the T-tube is the tendency toward displacement with a resulting obstruction to the passage of bile. Ginsburg and Speese report a case instancing this objection.

That the immediate result left nothing to be desired is evidenced by the following:

Recovery from the anæsthetic was slightly prolonged. There was little discharge from wound, and only upon the second day was there a trace of bile in the discharge. After the third day the dressings were dry. There was a *large brown* stool on the third day. The drains were removed on the sixth day, while the sutures remained until the eighth day. The patient was out of bed on the twentieth day, and was discharged from the hospital on the twenty-ninth day, gaining rapidly in weight and strength. The X-ray showed the rubber tube still present in the duodenum upon patient's release from the hospital. She returned regularly for examination, and at the end of the ninth week the X-ray showed the tube to have passed from the bowel. The general condition of the patient at the end of the ninth week was excellent, and she was again caring for her children and performing her household duties.

Our only fear at this point was that obstruction might develop as a result of cicatricial contraction of the newly formed duct. The patient was, however, entirely free from symptoms for over seven months, when she again applied for hospital treatment. I am indebted to Dr. B. W. Klippel, resident surgeon of the St. Louis City Hospital for the further history of the case.

Mrs. A. R. was readmitted to the City Hospital August 20, 1916. The patient had enjoyed good health uninterruptedly since operation until two days prior to her admission. The onset of her illness was very acute, with chills and fever, general abdominal pains, vomiting and diarrhœa. The patient attributed her illness to eating a large portion of potted ham. Examination showed: Temperature 98°; pulse 108. General abdominal tenderness was present, but no localized tenderness could be elicited. The abdominal scars were well healed. Leucocyte count was 9,600. The provisional diagnosis was ptomaine poisoning, and eliminative treatment was instituted. There was apparent improvement until August 24, on which date the patient chilled repeatedly, while the temperature rose to 101° and the leucocyte count to 17,400. The Widal reaction was

negative; no malarial plasmodiæ were seen in the blood smears. From this point the decline was very rapid, with exhibition of marked septic symptoms. A deep jaundice developed and the liver became distinctly palpable. Suspicion of liver abscess was here aroused, and the surgeons were asked to see the patient. On August 26 the surgical consultants advised against exploratory operation on account of the extremely bad condition of the patient. Death occurred on September 3, 1916.

Autopsy of same date. Many old adhesions were present in upper abdomen, involving omentum, stomach, liver, duodenum and parietal peritoneum. The old gastro-enterostomy was patent and had apparently continued to functionate. The gall-bladder was absent. The common duct was very much dilated and contained a cherry-sized stone immediately above the duodenal termination of the duct. Hepatic ducts were patulous and contained a "purulent bile." The liver was much enlarged and contained multiple abscesses varying in size from a pea to a lemon. Several abscesses were visible on the liver surface. There were many enlarged glands along the course of the common duct, as well as a cystic tumor the size of a pigeon's egg. This tumor upon examination proved to be a cyst that had formed about a knot of chromic catgut which showed not the slightest trace of absorption.

The common duct when opened showed an inflamed mucous lining throughout its entire extent.

Cause of death. Multiple liver abscesses resulting from ascending infection of the bile-passages.

The patients' freedom from symptoms for seven months following the reconstructive operation demonstrated that our chief fear—that of stricture—was groundless. The autopsy showed on the contrary an actual dilatation which was, however, probably secondary to the stone formation. The presence of the stone and the death from multiple liver abscesses serve to emphasize the danger of calculus formation with ascending infection of the biliary passages. It is difficult to fix upon the primary factor in any instance, although we incline in this case to view the infection as secondary to the presence of the stone. The stone resulted most likely from regurgitation and stagnation of bile due to lack of a valve at the duct opening, as well as to the peculiar nature of the wall of the reconstructed portion of the duct. The presence of the tube in the duct for several weeks doubtless also predisposed to stone formation. The cystic tumor about the catgut knot suggests that another knot may have formed the nucleus for the stone.

Summary of case report. At an operation for acute gall-bladder disease no stones were found, but a markedly diseased gall-bladder which had drained spontaneously into the duodenum. Cholecystectomy was performed, during which the common duct was accidentally injured and the duodenum necessarily opened. The duodenum was repaired, a gastro-enterostomy made, and the common duct drained. A duodenal fistula developed on the fourth day and healed spontaneously five days later. A complete biliary fistula persisted after the primary operation, and at the secondary operation this was found to result from a defective bile-duct. The loss of a portion of bile-duct was produced by necrosis in all probability occasioned by infection and the digestive action of duodenal contents. A Sullivan's reconstruction was successfully performed with brilliant immediate results. Death occurred over seven months after the reconstructive operation, being caused by multiple liver abscesses, secondary to ascending infection of the bile-passages. Secondary stricture of the ducts did not occur.

CONCLUSIONS

We feel that we are justified in suggesting the following conclusions:

1. In certain cases of bile-duct reconstruction necessity may compel the employment of Sullivan's operation, which, while not a method of choice, may prove to be of great worth.

2. Two dangers militate against a permanent satisfactory result: (a) stenosis of the new formed duct by cicatrization; (b) stone formation and ascending infection of bile passages.

3. Danger of cicatricial stenosis may be minimized by keeping the tube in the newly formed duct sufficiently long to allow complete epithelialization and thorough establishment of the newly formed duct. This period depends upon the extent of the gap to be bridged.

4. Calculus formation and infection of the biliary passages may be in a measure guarded by: (a) Avoiding non-absorbable sutures. (b) Not allowing the tube to remain permanently. If the tube does not pass at the proper period it should be removed by operation. Both spontaneous passage and operative removal may be facilitated by allowing the tube to project a few inches into the duodenum. A T-tube which can be removed at will without operation may be superior to the tube as employed by us. (c) Formation, if possible, of a valvular opening into the duodenum.

5. Gastro-enterostomy is to be advised as a rational procedure in cases where fears are entertained for the security of a duodenal repair.

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